AEDC-ENGR-STD-T-3

–AEDC STANDARD–

ENGINEERING DESIGN AND DRAFTING PRACTICES

Engineering Design and Drafting Practices
AEDC-ENGR-STD-T-3
June 1973
General Revision
1 December 2001

l. This standard has been approved by the Design Specifications Working Group (DSWG), and is mandatory for use, except where noted, by all Support Contractors at AEDC in engineering design and drafting activities.

2. Correspondence, comments and questions pertaining to this standard should be directed to DSWG through its members listed below.

3. The use of and reference to traditional units, such as foot, pound, and psi, in this standard shall not be construed as mandating the exclusive use of traditional units on engineering drawings and designs originated at AEDC. System International (SI) units, generally referred to as metric units, may be used as required in designs, when done in accordance with applicable standards and sound engineering practice.

A. F. Simmons
Deputy Base Civil Engineer
USAF/AEDC/SDF
DSWG Chairman

T. F. McGill
Manager, Design Engineering
Sverdrup Technology, Inc.
DSWG Representative

Katherine E. Nichols
Manager, Design Engineering
ACS
DSWG Representative

T-3 REVISION RECORD	
DATE	**AFFECTED PAGES**
1 December 2001	Basic Document.

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1.0 INTRODUCTION

1.1 PURPOSE

This standard provides criteria for continuity and uniformity in engineering design and drafting practices at AEDC.

1.2 SCOPE

Engineering design and drafting performed at AEDC in preparation of engineering drawings, drawing revisions, engineering changes, engineering sketches, site plans, and real estate drawings shall be in accordance with the provisions of this standard.

1.3 DEFINITIONS

a. **Engineering Layout—**A drawing or sketch which presents sufficient engineering informationto adequately identify a component, assembly or installation, from which an engineering drawing and/or a cost estimate can be prepared.

b. **Engineering Drawing—**A drawing which presents engineering information that is easily understood and in sufficient detail so that an article or assembly may be fabricated, assembled, inspected, and installed in an efficient and timely manner.

c. **Drawing Revision—**Any change made to a previously released drawing.

d. **Drawing Status—**Status assigned to drawings during their life cycle to define their approprate use within Metaphase.

In Design— Drawing is in the process of being created or revised. A drawing is automatically in “In Design” status when it is initially created or when a new revision level is created.

Approved— A drawing that has been approved through the design process and is authorized to be released for work.

On Shelf— The drawing defines work that may be executed in the future. It is usually part of an I&M/M&R project that will be released for work when funding becomes available.

In Execution— A drawing that represents work that has been funded and is currently in execution. (use of this status is optional)

Drawing of Record— Drawing that best defines the current configuration in the field but has not been verified to be as built. All drawings in real property as of 9/1/98 have a default status of “Drawing of Record”.

As Built— A drawing of record that depicts the current as-built configuration in the field.

Obsolete— The drawing has been superceded or voided and will not be used in the future for doing work, or the item depicted in the drawing is no longer in existence.

e. **Engineering Change Proposal** (ECP) - Address through the current engineering management process.

f. **Notice of Revision (NOR)** - A form (GC-1359) used to make changes (deviations from released drawings) until a drawing revision can be made. It becomes a part of the drawing until a revision is made to the released drawing to incorporate the change.

g. **Engineering Sketch** - A sketch may be used to accomplish in-house (AEDC) fabrication and installation work for temporary systems requiring hardware of a non-permanent nature where a drawing does not exist and existing drawings are not affected. A sketch may be prepaired on any format; however, Form GC-1524 is provided as a convience in preparation of sketches.

h. **Site Plan—**A detailed functional drawing which expands on the general site shown on the AEDC Base Comprehensive Plan.

i. **Real Estate Drawing—**A drawing used to show proposed or existing leases, rights-of- way, easements, and other similar layouts.

j. **Cover Sheet—**A drawing normally prepared only for design packages used in off-base acquisitions. It serves as the lead drawing and depicts the job site, contains vicinity maps, gives an index of package drawings (if not too extensive), and shows other graphic details as needed.

1.4 EXCEPTIONS

Some AEDC data are retained in a drawing format due to their nature, use, history, distribution, and method of control. These include electrical system load dispatcher drawings, electrical system impedance diagrams, and similar data normally not filed in Real Property Records. These are exempt from the provisions herein but, shall be controlled by the responsible contractor's internal procedures.

2.0 DESIGN AND DRAFTING STANDARDS

All drafting will comply with the latest edition of the following standards, codes and practices.

2.1 AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)/AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

2.1.1 Standard Drafting Practices

a. Y14.38—Abbreviations for Use on Drawings and in Text

b. Y14.2—Line Conventions, Sectioning, and Lettering. (Letters smaller than type three will not be used on drawings.)

c. Y14.3—Projections

d. Y14.4—Pictorial Drawings

e. Y14.5M—Dimensioning and Tolerancing

f. Y14.5a—Interconnection Diagrams

g. Y14.5b—Supplement to Y14.5M and Y14.5a, Drafting Practices Electrical and Electronic Diagrams

h. Y14.6—Screw Threads

i. Y14.7—Gears, Splines, and Serrations

j. Y14.9—Forgings

k. Y14.10—Metal Stampings

l. Y14.11—Plastics

m. Y14.14—Mechanical Assemblies

n. Y14.15—Electrical and Electronic Diagrams

o. Y14.17—Fluid Power Diagrams

2.1.2 **Standard Graphical Symbols**

a. C37.2—Electrical Power System Device Function Numbers

b. X3.5—Flowchart Symbols and Their Use in Information Processing

c. Y2.4—(ANSI/AWS 2,4) Symbols for Welding and Nondestructive Testing

d. Y32.2—Electrical and Electronic Diagrams

e. Y32.2.3—Pipe Fittings, Valves and Piping

f. Y32.2.4—Heating, Ventilation, and Air Conditioning

g. Y32.2.6—Heat Power Apparatus

h. Y32.4—Plumbing

i. Y32.9—Architectural and Electrical Layout

j. Y32.10—Fluid Power Diagrams

k. Y32.11—Process Flow Diagrams

l. Y32.12—Metallizing Symbols

m. Y32.14—Logic Diagrams

n. Y32.16—Reference Designations for Electrical and Electronic Parts and Equipment

o. Y32.17—Nondestructive Testing Symbols

2.1.3 **Standard Design Practices**

a. B4.1—Preferred Limits and Fits for Cylindrical Parts

b. B18.6.1—Hexagon Head Cap Screws, Slotted Head Cap Screws, Square Head Set Screws, and Slotted Headless Set Screws

c. B46.1—Surface Texture

2.2 AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

a. Manual of Steel Construction

b. Structural Shop Drafting Textbook

2.3 AMERICAN WELDING SOCIETY (AWS) STRUCTURAL WELDING CODE

a. D1.1—Steel

b. D1.2—Aluminum

2.4 INSTRUMENT SOCIETY OF AMERICA (ISA)

a. ISA-5.1—Instrumentation Symbols and Identification

2.5 NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

a. National Fire Codes

2.6 NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

a. ICS, Industrial Controls and Systems

2.7 JOINT INDUSTRIAL COUNCIL (JIC)

a. EMP-1, Mass Production Equipment

b. EGP-1, General Purpose Machine Tools

2.8 AMERICAN INSTITUTE OF ARCHITECTS (AIA)

a. Architectural Graphic Standards (Ramsey & Sleeper)

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3.0 DRAWING SHEET & FORM STANDARDS

3.1 DRAWING SHEETS AND FORMS

The following authorized drawing sheets and forms are for use at AEDC. Special case drawing sheets and forms may be used with DSWG approval.

Table 3.1 Authorized Drawing Sizes

Item	Size (In. × In.)	Designation	Stock/Form	Ref. Fig.
Standard Drawing Sheet	22 × 34	D (Preferred)	CAD/CAM	3.4
Standard Drawing Sheet	34 × 44	E (Preferred)	CAD/CAM	3.4
Optional Drawing Sheet	28 × 40	S	CAD/CAM	
Maps 1x40	28 × 40	S		
Maps 1x400	34 × 44	E (Preferred)		
Standard Sketch Sheet	11 × 17	B (Preferred)	CAD/CAM	
Notice of Revision	8 1/2 × 11		GC-1359	

Standard CAD drawing start models (Metaphase controlled), consistent with the forms indicated in the table above, shall be used for all new drawings. Hard copy drawings may be plotted on any paper that meets the needs of those producing and using the drawings

3.2 BILLS OF MATERIALS (BOMS)

All fabrication drawings shall specify the material required for construction. The cut size, quantity, and other such data is optional, normally depending on the requirements of the construction organization.

Typically, a BOM is provided as the first sheet of the drawing set. It is permissible to have the information on a separate material specification document that is clearly referenced on the drawing. This document must be clearly attached to the "drawing package" in Metaphase to insure material requirements are permanently maintained with the drawing.

3.3 TITLE BLOCK/BOM INSTRUCTIONS

3.3.1 BOM’s shall be included in the drawing set as needed, and retained with the drawing when filed in Metaphase.

3.3.2 **Block Instructions**: Numbers correspond to blocks in Figures 3.3 and 3.4. See Figure 8.1 for details of the site plan drawing title block.

1. **Drawing Identification**

   a. **Drawing Number:** See Section 4.0

   b. **Revision:** See Section 7.0.

   c. **Reference Number:** Enter the reference number applicable to the drawing section. A listing of acceptable reference numbers are shown in table 10 of the Tri-Services Technical Report CADD-93. The number consists of two parts – the type code (an alpha character(s)) and the section sheet number. The codes define the types of drawings in the various sections of a drawing set. A partial listing of code types are listed below:

      (1) CS – Cover Sheet (Job Site, Vicinity Maps, Drawing Index, Graphics)

      (2) I – Index

      (3) C – Civil (Paving, Grading, Drainage, Site Plan)

      (4) SD – Steam Distribution

      (5) H – Water & Sanitary (Sewer, Waste Treatment)

      (6) F – Geotechnical & Materials

      (7) L – Landscape

      (8) A – Architectural

      (9) S – Structural

      (10) P – Plumbing (Potable and Raw Water)

      (11) FP – Fire Protection

      (12) M – Mechanical (HVAC, Pressure Systems)

      (13) E – Electrical/Instrumentation

      (14) HM – Hazardous Materials Removal & Abatement (Asbestos, Lead, etc.)

      The section sheet number is the specific sheet number in the particular drawing section. For example, a section of structural drawings will have a type code of “S”. The first sheet in the section will have a reference number of “S1”. Continuation sheets will be “S2”, “S3”, etc. References to other sheets in the section are made by using the reference number; for example, “See Detail A on S5”. The reference number shall be the only indicator in the configuration control numbers, which refers to and defines the type of drawing. A drawing set may have more than one drawing section. A drawing index listing all drawings shall be included on the Cover Sheet (CS1). However, if the number of drawings is numerous and sufficient room is not available on the Cover Sheet, use the Index Sheet to list them. Figure 3.1 and Table 3.2 illustrate usage of the reference number in a drawing set.

The (Sheet_____ of _____) located in block (1c) is to be in reference to the total number of sheets of the section.

d. Sheet Number (Existing Drawing): The sheet number in block (1d) is based on the total sheets associated with the drawing number.

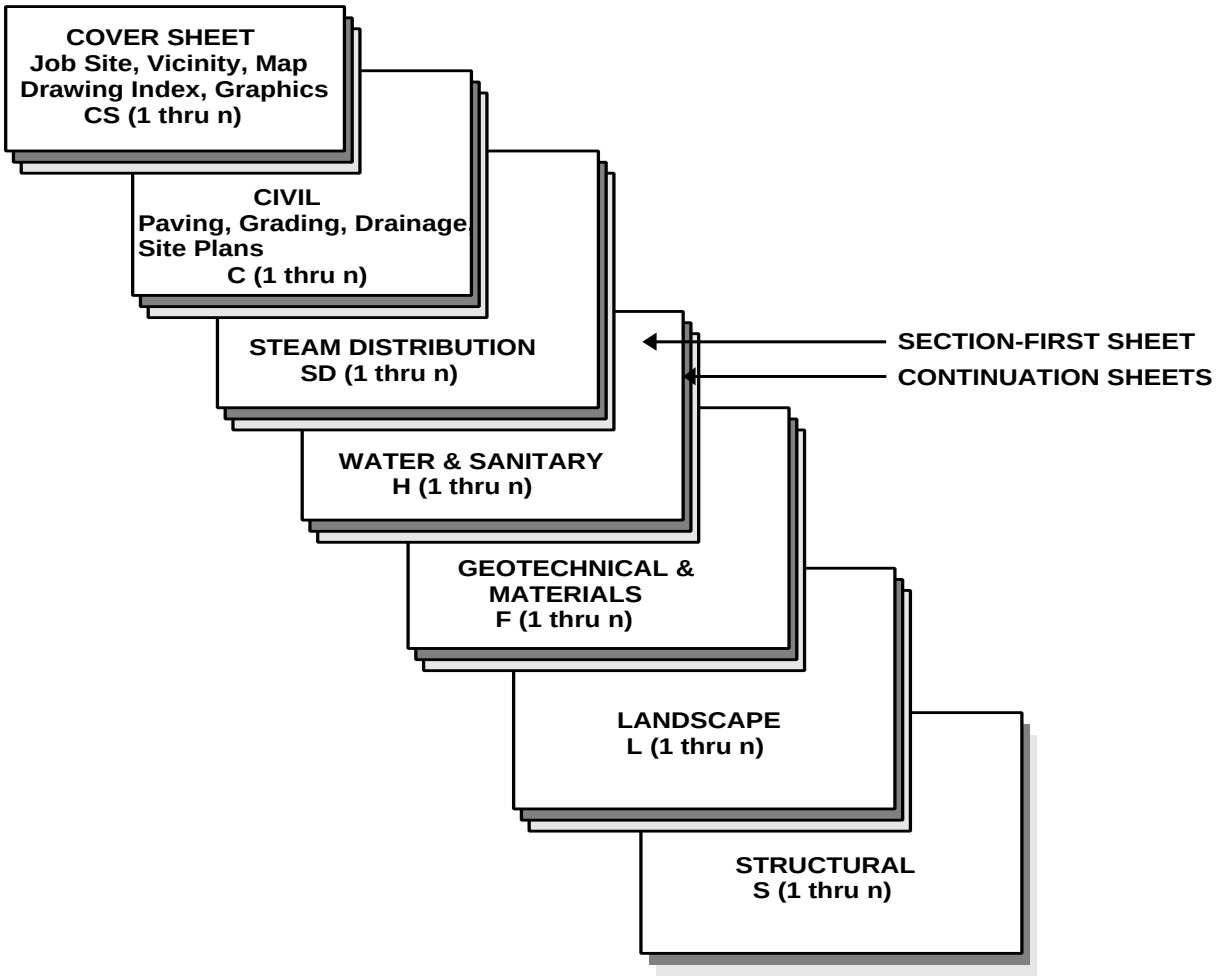

Figure 3.1 Typical Drawing Set

Table 3.2 Drawing Index (See 3.4.3.1.c)

DRAWING INDEX			
Ref. No. Code	Drawing Title	Drawing No.(optional)	No. of Sheets
CS	Cover Sheet	PYT10739.00	1
C	Paving and Grading	PYT10739.01	4
H	Sewer Line Details	PYT10739.02	3
F	Concrete Supports	PYT00831.01	2
E	Wiring Diagrams	PYT10739.03	3
M	HVAC Details	PYT01877.01	4
L	Driveway Landscaping	PYT10739.04	2

2. **Function Approvals:** Enter the name of the person reviewing and approving the document for the function noted (See 5.2). The date of approval shall also be entered.

3. **Drawing Identifications:** Drawings are identified by the drawing title and project title. If prepared for outside acquisition, by the project title.

   a. **Drawing Title:** The title shall contain the following information:

      (1) Information describing the subject material presented in the drawing (consideration should be given to the fact that the first two words will appear on Real Property Index books).

      (2) The type of drawing (details, installation, etc.).

      (3) The association with major equipment and/or location.

      The title shall be as brief and descriptive as possible. Use the formats below to give the above information.

Two-Line Titles

1st Line: Item (1) followed by a dash followed by Item (2)

2nd Line: Item (3)

Three-Line Titles

1st Line: Item (1)

2nd Line: Item (2)

3rd Line: Item (3)

b. **Project Title: Enter** the project title (three lines maximum) if prepared for outside acquisition.

4. **Scale:** Enter the predominant scale (or "as noted") to which the drawing sheet has been prepared.

5. **Blank:** May be used for other information user's option. If used, the block shall be appropriately headed (such as MR Number).

6. **Job No.: Enter** the job number for the project.

7. **System Engineer: Enter** the name of the individual responsible for the system being designed.

8. **Drawing Index No.:** A drawing identification number established from each facility's drawing codes. Reference Section 22.

9. **Outstanding NORs Enter** outstanding Notice of Revision numbers. Remove those numbers when the NORs are incorporated into the drawing. See Enterprise Process Manual for time limits on incorporation.

10. **Tolerances:** Serves as a general drawing note on tolerancing. (See ANSI Y14.5M). The hole tolerance block governs all hole sizes unless otherwise specified. The surface texture symbol may be completed by adding the appropriate roughness average (R_a) number. It will then serve as a general note, which applies to any machined surface on the drawing.

11. **Next Assy:** To be used to indicate the next assembly drawing number and the quantity required for that assembly.

12. **Item No.:** a. For machine drawings, enter dash numbers.

    b. For piping or structural drawings, enter item numbers.

    c. For electrical drawings, enter item numbers.

13. **Stock No.: Enter** Supply's stock number. Use the MR number for advance orders.

14. **UM:** Unit of issue listed in the stock catalog or required if not listed.

15. **Quantity:** The quantity of an item must equal the next higher whole unit of measure if a partial unit of measure (U/M) is needed. For example, if you need 115 bolts and the unit of measure is "BX (100 per BX)", you must order two boxes. When less than a whole U/M is required, check to see if the material is available in bench stock. Consider using bench stocks as the source of BOM requirements, especially when the quantity is less than a full U/M. Steel yard type material is an exception and may be rounded off to the nearest tenth of a U/M, such as 2.8 ft, when stock material is ordered. For cut-sized items, enter the raw stock quantity required to make the part.

16. **Part and Material Description:** Enter one of the following as applicable.

    a. A brief description (noun only) if the stock number is known.

       NOTE: When an old BOM/design package is reactivated, all stock numbers must be reviewed against the stock number directory.

    b. For a commercially obtainable item, the noun (VALVE, CHECK), the basic description (3", 6000 psi, carbon steel, raised face, etc.), manufacturer (Jamesbury), and the part number (#540867).

    c. For structural material, the shape of the material, size

       (Dimensions/salient characteristics) the type of material, and applicable material specifications.

       Examples: (1) Plate - 1.0" Thk × 7" W × 8" Lg, Aluminum, 6061-T-6, AMS 4027D.

       (2) Bar - 3.0" Dia., Carbon Steel, AISI-C-1018.

       (3) Angle - 3" x 3" x 1/4", Structural Steel, ASTM-A36-62T.

       (4) Cable - #14 AWG, Wire, 1/C, THWN

17. **Cut Size:** Enter the raw stock cut dimensions required to make the part (cite the standard material dimensions in Block 16).

    Examples: (1) For round bar – 3 pc, 6' long

    (2) For plate – 1 pc, 60" x 192"

    (3) For pipe, angle, cable, etc. – 1 pc, 10' long.

18. **Remarks:** This block is used for special information, such as for a long lead-time item, critical item, "DO NOT SUB" justification, and information about the system, equipment, etc., in which the item will be used.

    NOTE: If an item is being ordered several times on one BOM, in the Remarks column for the first item enter (Makes items #3, 5, 21, etc.)

19. **SH:** Enter the drawing sheet number on which the part callout is found.

20. **Prepared by:** Enter the support contractor name.

21. **Revision Block (top right corner of drawing sheet):** See Section 7.0.

22. **ACES No.:** Projects by Automated Civil Engineering System (PDC No.).

23. **Coordination:** Person and organization symbols of offices having project input as determined by its scope and as required by the responsible Air Force Project Manager.

24. **Approve by:** Authorized person who approves the drawing for release. (Revision control starts immediately when name is entered in block).

25. **"PRELIMINARY UNAPPROVED – NOT FOR FABRICATION" Stamp:** To prevent field use of preliminary, unapproved prints which are to be used only for review, cost estimates, planning, etc., the phrase "PRELIMINARY UNAPPROVED – NOT FOR FABRICATION" shall be placed on such individual prints in the vicinity of the title block.

26. **"ADVANCE DRAWING – NOT FOR OPERATION" Stamp:** To allow work to be performed when an emergency or urgent schedule justifies the cost of having to modify or remake a part when the design is completed, an advanced drawing may be utilized with the signature approval of the appropriate Design Manager and his organization code. The words "ADVANCE DRAWING – NOT FOR OPERATION," shall be clearly marked on individual prints in the vicinity of the title block. Final approved drawings shall be released prior to final acceptance and operation of the components.

3.4 DRAWING DETAIL IDENTIFICATION FOR MACHINE DRAWINGS

During the manufacturing process, drawings are often divided so that several parts can be manufactured simultaneously from the same set of drawings. Consequently, a drawing sheet may be cut into several sections and distributed to various shop work areas for manufacture. To assure traceability back to the original control drawing, each drawing detail shall be blocked in by horizontal/vertical lines and shall reference the original control drawing number in the lower right corner of the block.

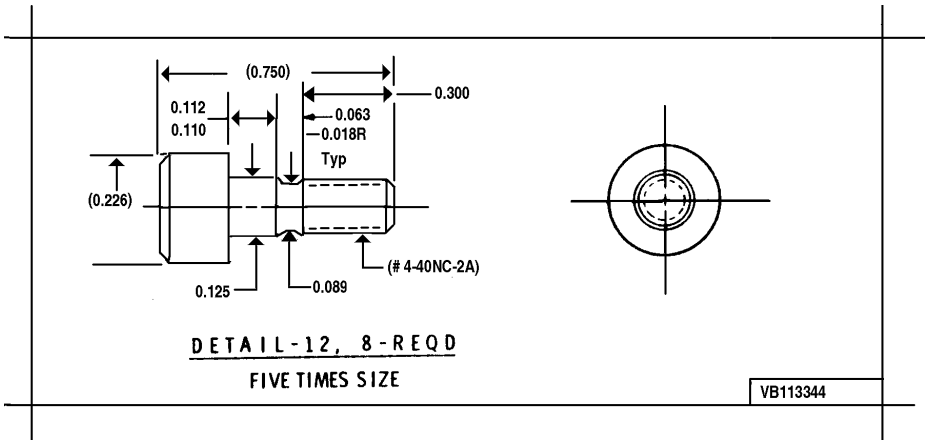

Figure 3.2.

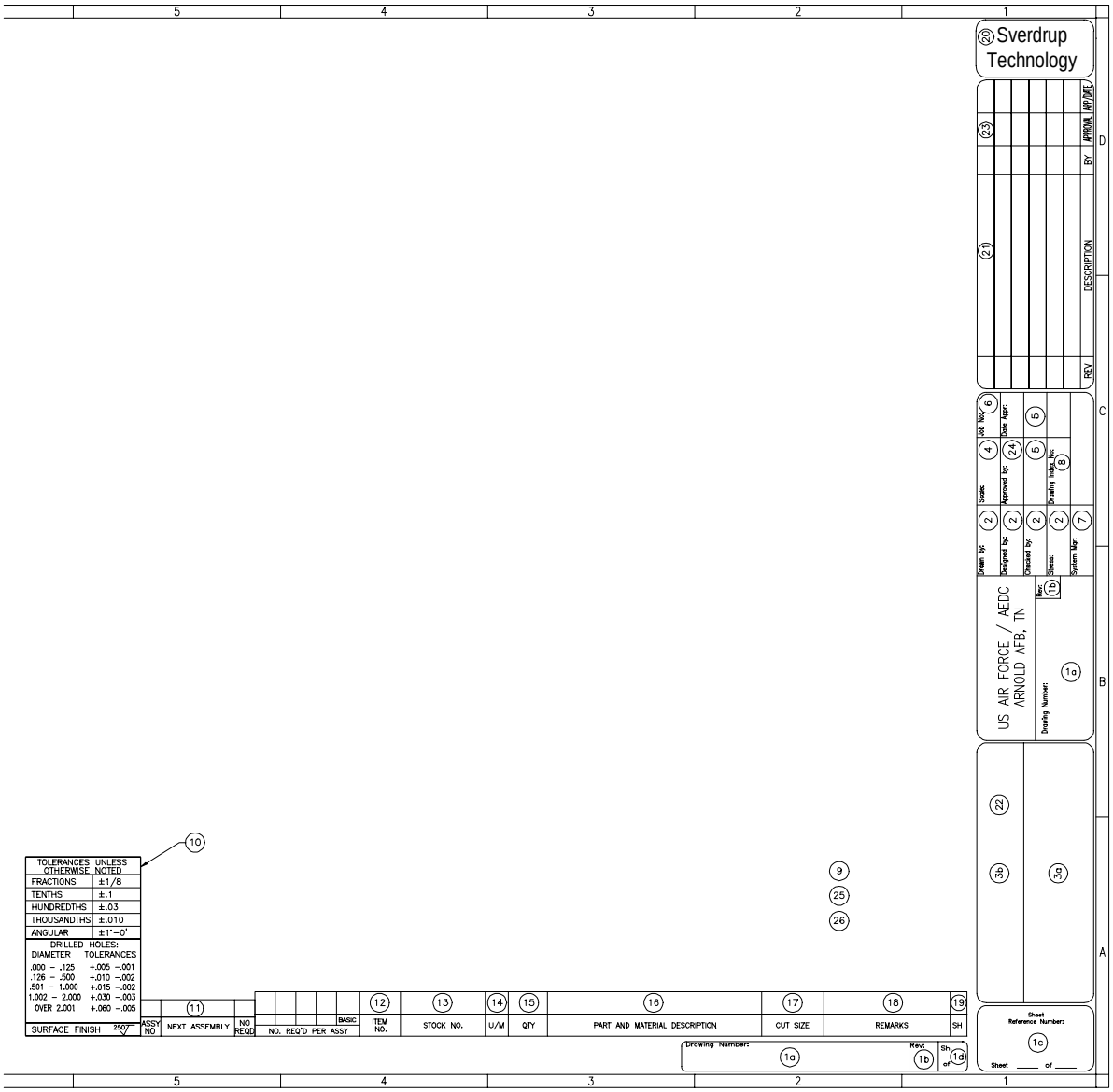

Figure 3.3 Standard Title Block

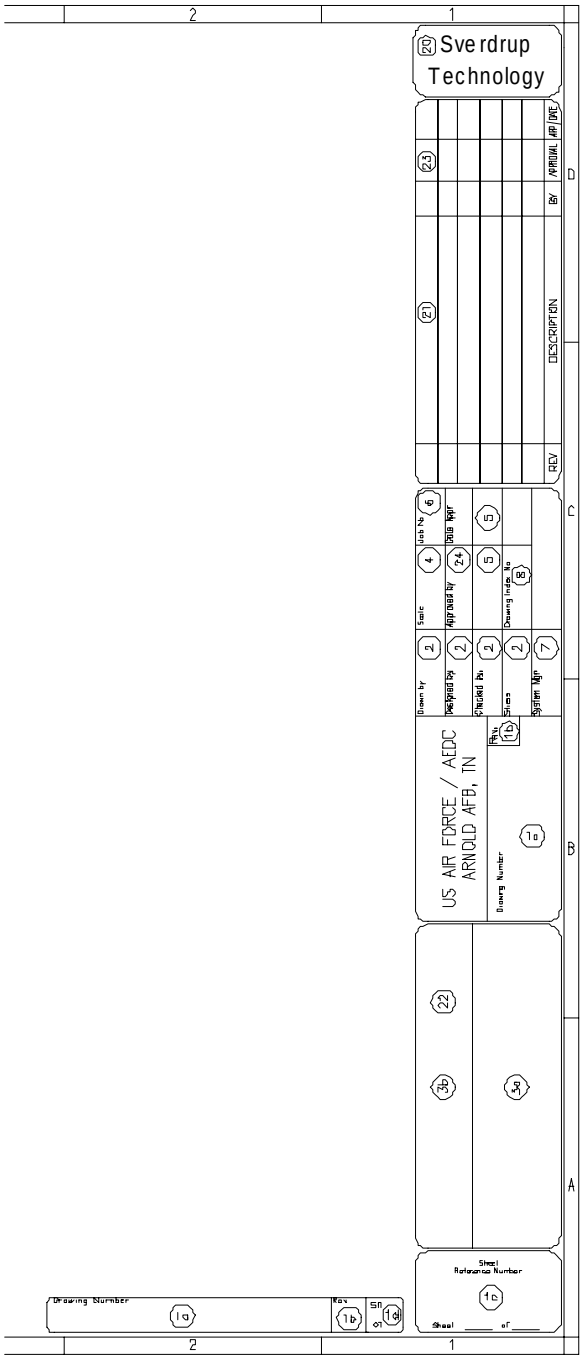

Figure 3.4 Standard Reduced Title Block

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4.0 DRAWING AND SKETCH NUMBERING REQUIREMENTS

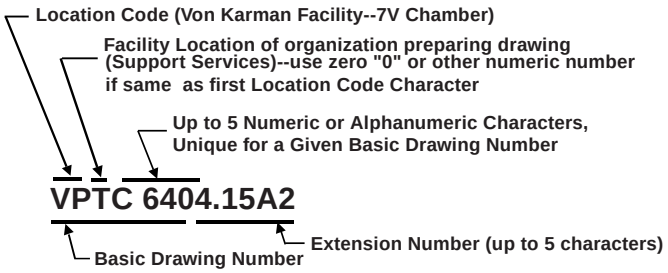
This section defines the requirements for drawing and sketch numbering. Each Contractor is responsible for maintaining a numbering system for drawings and sketches in accordance with this section. The system used will maintain a log of the drawing or sketch number, title, and person preparing documents, their 4-letter organization, and log date.

4.1 BASIC DRAWING NUMBER

The basic drawing number system shall consist of eight alphanumeric characters with optional extension numbers (up to 5) defined as follows:

CHARACTER	DESCRIPTION
1st	**Facility** / **Organization** for which the drawing was prepared. See Table 4.3.1, Standard Organization Codes (Table 4.3.2 provides expanded description)
2nd	**Location/System within the Facility**, such as T-1, J-2, Tunnel A, etc. See Table 4.3.1
3rd	**Facility** preparing the drawing. A zero **"0"** or other alpha number used in this space will indicate that the preparing organization (company) is also responsible for operation of the subject Facility.
4th thru 8th	**Numeric or alphanumeric sequence** (BASIC DRAWING NUMBER).
9th	**Period** to designate a brake between the BASIC DRAWING NUMBER and EXTENSION identifying characters.
10th thru 14th	**Additional numeric or alphanumeric characters** (up to 5), unique for a given BASIC DRAWING NUMBER. (these supplementary numbers follow the period (9th character) and are referred to as the “Point Numbers”)

4.1.1 DRAWING NUMBER EXAMPLE

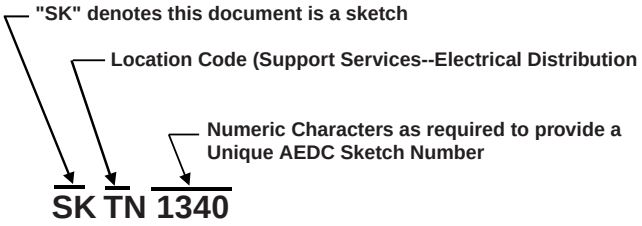


4.2 BASIC SKETCH NUMBER

The basic sketch number shall consist of 4 alpha characters, which define the document as a sketch, and identifies the location code, followed with additional numeric and/or alphanumeric characters necessary to insure the sketch number is unique. Description is as follows:

CHARACTER	DESCRIPTION
1st & 2nd	"**SK**" which defines the number as a sketch number
3rd	**Facility** / **Organization** for which the drawing was prepared. See Table 4.3.1, Standard Organization Codes (Table 4.3.2 provides expanded description)
4th	**Location/System within the Facility**, such as T-1, J-2, Tunnel A, etc. See Table 4.3.1
5th thru n	**Numeric and/or alphanumeric sequence**

4.2.1 SKETCH NUMBER EXAMPLE



4.3 DEFINING FACILITIES AND LOCATION CODES

The Location code is comprised of two alpha characters which define the Facility and Test Cell (or designated area).

4.3.1 CURRENT LOCATION CODES

Tables 4.3.1 defines the Location Codes to be used for drawing and sketch numbers. Table 4.3.2 provides expanded information on the Facility Code definition.

Table 4.3.1
System Location Code Designation

Code	Air Force	ETF		VKF	PWT	Support
1st→ 2nd↓	L	R	E	V	P	T
A	A&E	T-1	SL1	A	1-T	A&E
B	NCO Club	T-2	SL2	B	4-T	PMEL (ICL)
C	Officers Club	T-3	SL3	C	DET	Power Control
D	Arnold Village	T-4	SL2/SL3	D	HEAT-1	Elk River Dam
E	Oper. Center	R-2C4		E	RENT	Model Shop
F		C-Side General		F	16S	N2 Dist. Sys.
G		Turbine Area General	T11	G	16T	Chem. & Met. Lab.
H		T-6	T12	APTU		Sec. Pump. Sta.
I		T-5		DECADE		Water Treat. Plant
J	Woods Res. Area	J-1		IMPACT IMPULSE	H4	Sewage Tr. Plant
K		J-2	Tunnel 9	K	H3	I&M Bldg.
L	BX, Commissary	J-2A		SGTC		Water Dist.
M		J-3		ACL	Main Drive	Elec. Dist.
N		J-4		N		Steam. Dist.
O		C-1		MK-1		Communications
P		J-5		7V	PES	Disp./FP&C
Q		J-6		10V		Logistics
R		RPA		12V	Drier	Auto Repair Shop
S		Rocket Area General		S		Fire Protection
T		GLTS		IVA	16S, 16T	Fuel Farm
U		Plant		Plant	Plant	Security Systems
V		C-2		Res. Ch.		Helium Systems
W	Technology or General Research					
X		T-7		H2		
Y		Computer		General		
Z	Inter-Facility	**Z**	Inter-Facility	**Z**	Inter-Facility	**Z**

Table 4.3.2
Facility/Organization Codes

ENGINE TEST FACILITY (ETF)	**R** or **E**
AIR FORCE	**L**
VON KARMAN FACILITY (VKF)	**V**
PROPULSION WIND TUNNEL FACILITY (PWT)	**P**
SUPPORT SERVICES	**T**

4.3.2 **HISTORICAL LOCATION CODES** (for reference only)

Tables 4.3.3 defines the Location Codes used for drawings prior to 1982. Table 4.3.4 provides expanded information on the Facility Code definition used prior to 1982.

TABLE 4.3.3
System Location Code Designation
(Inactive -- For historical Reference Only Prior to August 1982)
See Table 4.2A For Current Codes

CODE	PWT	ETF	TSD	VKF	FSD	GSD
1st →	P	E	T	V	F	G
2nd ↓						
A	1T	T-1	A&E	AB	Power Control	B&G Shops
B		T-2	ICL	B	Elk River Dam	B&G Grounds
C	4T	T-3		C	Primary Pump. Sta	B&G Custodial
D	V/STOL	T-4	Dispensary, FPIC	D	Sec. Pump. Sta.	B&G Eng.
E	DET	R-2C4	Model Shop	E	Water Treat. Plant	Inform. Serv.
F				F	Sewage Treat Plant	Log.-Materials
G		T-General	Chem. & Met. Lab.	G	Steam Plant	Log.-Transp.
H		T-6	Bldg.	H		Office Serv.
I		T-3		I		Mgt. Publications
J		J-1	Woods Reservoir Area	J		Fire Protection
K		J-2	Warehouse, Fuel Farm	K		Guard Branch
L	5-MW	J-2A	BX, Commissary	L		Security
M		J-3		M		
N		J-4		N		
O				MKI		
P		J-5		7V		
Q		GLTS		10V		
R		APTU		12V		
S		J-General		S		
T	16S, 16T	Multifunction		IVA		
U	Plant	Plant		Plant		
V				Res. Ch.		
W	Technology or General Research					
X						
Y	General					
Z	Inter-Facility					

INACTIVE

TABLE 4.3.4

Standard Organization Codes
(Inactive -- For historical Reference Only Prior to August 1982)

Office of General Manager	**B**
Facility Support Department	**F**
General Support Department	**G**
Air Force	**L**
Propulsion Test Facility	**P**
Engine Test Facility	**R**
Technical Support Department	**T**
Von Karman Facility	**V**

(See Table 4.1A for current codes)

5.0 APPROVAL AND REVISION OF ENGINEERING DRAWINGS AND SKETCHES

5.1 PURPOSE

This standard defines requirements for approving and revising drawings and sketches.

5.2 APPROVAL OF ENGINEERING DRAWINGS AND SKETCHES

5.2.1 **Minimum Approvals.** For a Drawing or Sketch to be properly approved, it must identify as a minimum (1) "Drawn", (2) "Checked", and (3) "Approved". Only authorized persons shall "Approve" drawings or sketches and this person shall ensure all needed reviews and approvals have been properly obtained. For Sketches, the same person may draw and approve, or check and approve the document, but can not draw and check it. For drawings, the three minimum reviewers must be different people.

Note: A drawing or Sketch status is **"Approved"** once a name and date is entered into the **"Approved by"** block. Any change to the original document requires a revision.

5.2.2 **Approval Blocks.** Table 5.1 lists the various 'Title/Function' approval blocks used on AEDC engineering drawings and sketches. Each title or function listed by an approval block implies certification or review by a qualified person in that area. The only exception is the 'Drawn' block, which gives the name of the drafter who prepared the drawing. Not all drawings will have every approval listed below. However, preprinted blocks will always be completed; if not applicable to the particular drawing or sketch, the block will be marked "NA". For Drawings, the Design Engineering Supervisor has the responsibility to determine and obtain the required design certifications. For Sketches, the person approving the Sketch has like responsibilities (typically the systems manager, system engineer, project manager, etc.)

5.2.3 **Signatures.** Signatures on drawings or sketches are not required for those prepared electronically. The approver's name may be typed into the drawing blocks for electronic drawings, provided they have verbally or otherwise approved the drawing.

Table 5.1 Drawing Approvals

Title/Function	Explanation
Drawn	Prepares the drawing.
Checked	Verifies the drawing was accomplished in accordance with T-3. Verifies format, symbols, layout, accuracy, neatness, spelling, dimensions, completeness, and other necessary checks to ensure the drawing adequately defines the work to be accomplished. (**Can not** be the same person who prepared the document).
Design	Certifies the drawing meets design criteria. Certifies the design is functionally adequate in accordance with recognized engineering practices used in required engineering disciplines. Certifies that the drawings are registered in the electronic database (Metaphase).
Stress	Certifies the structural integrity of the design is adequate and that applicable design codes have been satisfied. Certifies special requirements such as deflection limitations, natural frequency, service life predictions, thermal stress response and dynamic response have been satisfied as predicted by analytical methods.
System Manager/Engineer	Certifies the design meets system performance parameters, is compatible with system interfaces, and satisfies life cycle configuration objectives.
Requester	Certifies the design as shown on the drawing and/or supporting analyses meets the criteria, other features of the design are satisfactory from a user's standpoint, and all information requested has been furnished. He does not certify the correctness of the design or the validity of related engineering analyses.
Approved	Certifies the general engineering approach is valid and that appropriate coordination reviews and approvals for the job have been accomplished as indicated by names and function on drawing or sketch. The document is now approved for work release and changes shall be noted as a revision.
Metallurgical	Certifies all welding depicted on the drawing is properly shown, materials are compatible, and the design complies with applicable ASME Boiler and Pressure Vessel Code, ANSI Piping Code, or AWS Structural Welding Code. Certifies the weld symbols are valid, material selections are proper for the stated environment of the design, and materials are specified in a valid manner.
Manager	Certifies engineering is complete and all parties concur on the design for complex or significant tasks.
Other	Other signatures may appear for special requirements. The Title/Function description should clearly identify the area certified by the signature. For example, "Safety" would imply review by the Safety Office with certification that applicable safety requirements had been satisfied. "Fire Safety" would imply review by a qualified representative certifying all applicable fire safety standards had been satisfied.

5.3 REVISION OF DRAWINGS AND SKETCHES

5.3.1 Revisions to drawings and sketches shall be noted by sequential alpha letter added at the end of the document number (“A”, “B”, etc). The information revised in the document will be designated by the same revision letter (and subscript) enclosed in a bold line, equilateral triangle. At the option of the designer, the latest revision may be accentuated through enveloping the revision with an irregular line.

5.3.2 Revision to drawings will also be documented in the revision block of the affected drawing sheet. Revisions shall be designated alphabetically, and where more than one change is made in preparation for a particular drawing release, subscript numbers will be added to the revision letter. The revision block on drawing sheet No. 1 shall include all of the sheet numbers that are affected by the revision. Drawing sheets not affected by a given revision will not include a revision letter in the revision block. All drawing sheet title blocks will be altered to include the latest revision letter.

5.3.3 When a drawing is revised to show it being superseded by a new drawing, the words “Superseded by Drawing No.” shall be printed in letters not less than 1/4 high, as near to the Title Block as possible, preferably just above the Title Block if space permits. Superseded drawings shall be released as the next change letter and carry the ‘obsolete’ status.

5.3.4 When a drawing is being revised to show it obsolete and will not be superseded by a new drawing, the word “Obsolete” or “Voided” shall be printed in letters not less than 1/4 high, as near to the Title Block as possible, preferably just above the Title Block if space permits. Obsolete drawings shall be released as the next change letter and carry the ‘obsolete’ status.

5.4 APPROVALS FOR REVISIONS

The minimum approvals (level) for revisions are the same as for originals as defined in section 5.2. Generally initials will note the approvals.

5.5 “RED-LINE” CHANGE PROCESS

5.5.1 Copies of Drawings or Sketches may be “Red-Lined” for temporary documentation and approval of a change to be made or to reflect the as-built condition of a system. The drawing or sketch shall be identified as “Official Redline Drawing/Sketch” with the responsible document owners name at the top of each page (the owner is the Supervisor for the work being performed). Only one “Official Redline Drawing/Sketch” shall be maintained per work order.

5.5.2 For documents involving ongoing work, the proposed change on the red-lined drawing shall be signed and dated by the job contact, the configuration manger or his designee, and Design Engineering (usually the designer). For configured systems only the CM signature or his designee’s signature is required to proceed with the work. For non-configured systems only the job contact or systems engineer signature(s) are required. In either case, all signatures are required within one workday.

5.5.3 For drawing deviations discovered on existing system configurations and where no modifications are being made, only the person recording the deviations is required to document the noted deviation. The configuration manager or his designee shall determine if a change to the physical item or the documentation is required and shall take appropriate action. All deviations shall be submitted through the system manager to Design Engineering for drawing revision and proper approval in a timely manner (14 work days or less).

5.5.4 At the close out of a work order, the “Redline Drawing”generated shall be noted in the work order remarks. If they have not been previously transmitted to the appropriate design organization for incorporation, they must be transmitted at this time.

5.5.5 All “Red Line Drawing” deviations shall be incorporated into the affected official Drawing Package located in the AEDC product data manager (Metaphase) within 30 work days of change authorization, and within 14 working days after close of work order, and prior to project close out. For test drawings (not affecting real property), the “Red Line” Copy may be scanned and filed as the current drawing (next rev level, “As-Built” or “Drawing of Record” status) in Metaphase. “Red Line Sketches” shall be returned to the originator for their records (they do not affect real property).

6.0 DRAWING MANAGEMENT AND STATUS DEFINITIONS

6.1 PURPOSE

The purpose of this standard is to establish minimum requirements for drawing management and to provide definitions of the statuses used in the AEDC drawing management process.

6.2 Drawing File Management

6.2.1 All AEDC drawings and associated electronic files will be managed and archived electronically using the product data manager (PDM) Metaphase. The Metaphase PDM will be the system used to provide a record of drawing approval and status, and to provide the revision control process.

6.2.2 Existing Hard-line Real Property drawings, prior to 1 Oct 2000, have been electronically scanned and filed in Metaphase as the official AEDC controlled drawing. These scanned copies are generally of good quality, but frequently are inadequate because of the existing microfilm quality from which they were made. In this case, a direct flat bed scan of the originals generally produces an acceptable quality copy.

6.2.2.1 Hard-line drawing copies shall not be added to the real property files after 1 Oct 2000. All drawings shall be electronically filed and managed in Metaphase. Electronic .dwg files are the standard; however, any CAD format used in preparing drawings should be filed with the drawing package in Metaphase as historical information for possible future conversion.

6.2.2.2 Hard-line drawings stored in Real Property files, with status of “As-Built” or “Drawing of Record”, shall continue to be maintained for reference until such time the electronic copy is verified to be 100% legible, or until it meets one of the conditions for destruction defined below.

Exception: Drawings generated outside of AEDC with the status of “As-built” or drawing of Record” shall not be destroyed unless they meet one of the conditions for destruction defined below. The Air Force and AEDC Contractors will periodically review this policy for adequacy.

6.2.2.3 Hard-line drawings where the original was AEDC CAD-generated may be destroyed without verification.

6.2.2.4 Hard-line drawings with status of “Obsolete” may be destroyed without verification.

6.2.2.5 Hard-line drawings revised after 1 Oct 2000 may be destroyed.

6.2.3 Microfilm drawing copies exist for all drawing prior to 1 Oct, 2000, at which time the requirement to Microfilm drawings was discontinued. The historical Microfilm cards will be maintained indefinitely for reference at real property.

6.2.4 Design requirements and analysis for new drawings shall also be stored electronically in the PDM after 1 Oct 2001. This information shall be appropriately referenced to the "Drawing Package" in Metaphase.

6.2.4.1 The minimum engineering documentation shall consist of (1) basic "Design Requirements" and (2) "Analysis" necessary to verify the design will meet requirements. Other related information may be filed for future reference at the discretion of the design team members. The emphasis will be on providing minimum engineering documentation (Requirements & Analysis) and to provide only additional information items with a high probability of future need.

6.2.5 Electronic backup of files stored in the PDM are as follows (as a minimum):

FILES	FREQUENCY OF BACK UP	PERIOD MAINTAINED	FILE BACKUP STORAGE
"In Process" work Files only	daily	4 weeks	1 copy local
All PDM Files	weekly	6 months	1 copy local
	monthly	1 year	1 copy (stored in another building)
	Yearly	2 years	1 copy (stored in another building)

6.3 **Drawing Status**

Each support contractor's drawing management process shall use the statuses given in 1.3.d to define the state of the drawing. The process shall assure that the current proper drawing status is recorded as Metadata in Metaphase for each Drawing Package. Only properly approved drawings with a status of **"Approved"** or **"In Execution"** shall be released for work. All drawings released for doing work shall be updated to reflect the actual work done prior to close out of project or work effort. The status of these updated drawings shall be **"As Built" or "Drawing of Record"** at job completion.

7.0 TYPICAL DRAWING NOTES

7.1 PURPOSE

This standard provides requirements for establishing typical drawing notes to be used on engineering drawings, change proposals, or sketches where applicable to establish uniformity in engineering design and drafting practices.

7.2 GENERAL REQUIREMENTS

The following information shall appear in the general notes on the drawing when applicable:

A.) Design temperature range

B.) Design pressure range

C.) Chemical environment

D. Design or load rating

E. Applicable industry standards & codes

7.3 ESTABLISHING STANDARD DRAWING NOTES

7.3.1 Standard basic drawing notes will be established by each AEDC contractor appropriate to their type of work.

7.3.2 The notes shall be grouped into appropriate disciplines to facilitate their use in the design process and in interpreting the drawing.

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8.0 DEVICE IDENTIFICATION

8.1 **Requirement** – Schematics (P&ID) are required for Process Systems. The Schematic/Diagram shall fully define the configuration and identify each device by tag name.

a. Device names must be unique to the Facility (as a minimum) to avoid duplicates and the potential safety hazard resulting from operating the wrong device. (Following preferred formats in 9.5.1.2 – 3 should insure unique names at AEDC).

b. Existing device naming formats are acceptable; however, for major modifications and new systems, the preferred formats defined herein shall be used.

c. A control process must be in place to insure names are not duplicated within an AEDC Facility.

8.2 **Process Piping Schematics** – The preferred AEDC Standard Device Identification method uses the following four-part alphanumeric scheme:

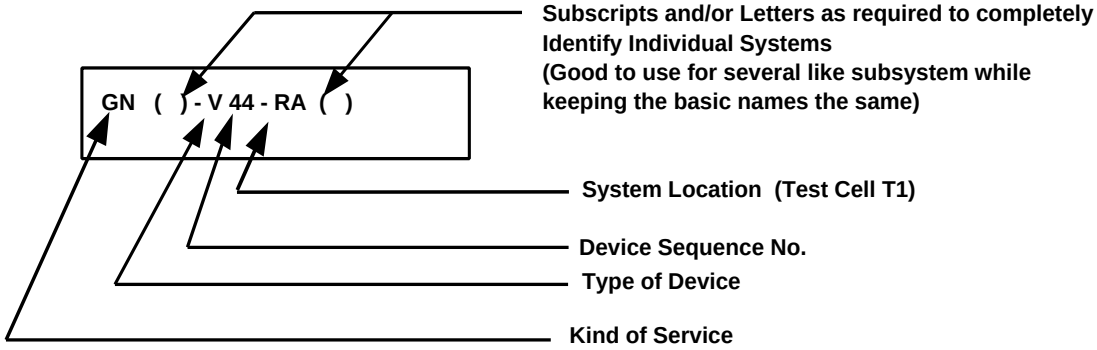
a. Kind of Service – Reference Table 9.3 (Multi-service example: GN/GHE)

b. Type of Device – Reference Auto Cadd on Screen Menues.

c. Device Sequence No. – Sequential number beginning at fills or supply end of system where practical – Reference Contractors "Device Log"

d. System Location – Reference Table 4.3.1 or Addendums 9.5.1, 9.5.2, 9.5.3.

Example: Preferred method for piping systems (Mechanical)



* Note: Section 9.5 specifically refers to schematic piping diagrams. The standard for device identification also shall apply to all design documentation (i.e., all other types of mechanical and electrical design drawings, equipment lists, etc.).

8.3 **Process Instrumentation Diagram** – Identification of Instrumentation and Control Devices shall follow the basic Instrument Society of America (ISA) Standard ANSI/ISA-5.1. The preferred AEDC standard name configuration consists of four basic parts as follows:

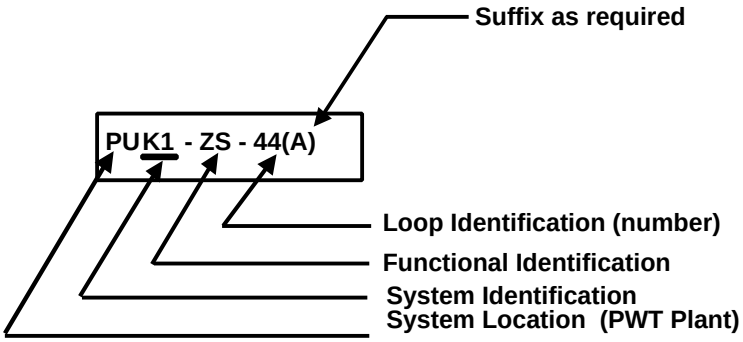
a. System Location—Reference Table 4.3.1 or Addendums 9.5.1, 9.5.2, 9.5.3.

b. System Identification – Alphanumeric character set shall identify the facility and system/location for the device (or identifies the facility and type of service).

c. Functional Identification – Character set defining the device type/function. (Reference ANSI/ ISA-5.1, Table 1 and Section 4.2.

d. Loop Identification – All devices in a specific control loop shall share a common loop sequence number. Devices common to two or more loops shall carry the identification of the loop that is considered dominant.

Example: Preferred method for control systems (electrical)



8.4 **Devices appearing on both instrumentation and process piping schematics** –

- Process instrumentation diagrams will use the assigned process piping name for mechanical components, such as valves (for a mechanical component control loop, the mechanical device sequence # should be used as the loop sequence number where possible).

- Likewise, process piping schematics will use the assigned process instrumentation name for electrical components, such as thermocouples.

- Only one device name shall be used even though it appears on both mechanical and electrical schematics.

8.5 Other AEDC System Location Code Formats

8.5.1 **ETF Plant Systems** – The following system location codes have historically been used in the areas noted (used exclusively for mechanical devices). They can be used today to maintain consistency; however, for major system modifications, consideration should be given to using the AEDC standard.

(1) First letter “U” for Plant Systems in the ETF Facility only

(2) Second letter-denotes geographical area in plant operations as follows:

RU – Plant wide system such as HPA (A&B) Plant (AEDC standard designation)
UA – A-Plant (Airside, Exhaust Area & J-Test Area)
UB – B-Plant (Airside, Exhaust Area & T-Test Area)
UC – A-Plant Airside
UD – B-Plant Airside
US - A-Plant Exhaust Area
UE – B-Plant Exhaust Area
UT – T-Test Area
UJ – J-Test Area
UF – J4/J5 Test Area
UG – ASTF Airside
UH – ASTF Exhauster
UK – ASTF Test Area
UL – ASTF Cooling Tower Area (Paws)

U= PLANT WIDE SYSTEM SUCH AS HPA (A&B) PLANT
UA= A–PLANT (AIRSIDE, EXHAUST AREA & J–TEST AREA)
UB= B–PLANT (AIRSIDE, EXHAUST AREA & T–TEST AREA)
UC= A–PLANT AIRSIDE
UD= B–PLANT AIRSIDE
US= A–PLANT EXHAUST AREA
UE= B–PLANT EXHAUST AREA
UT= T–TEST AREA
UJ= J–TEST AREA

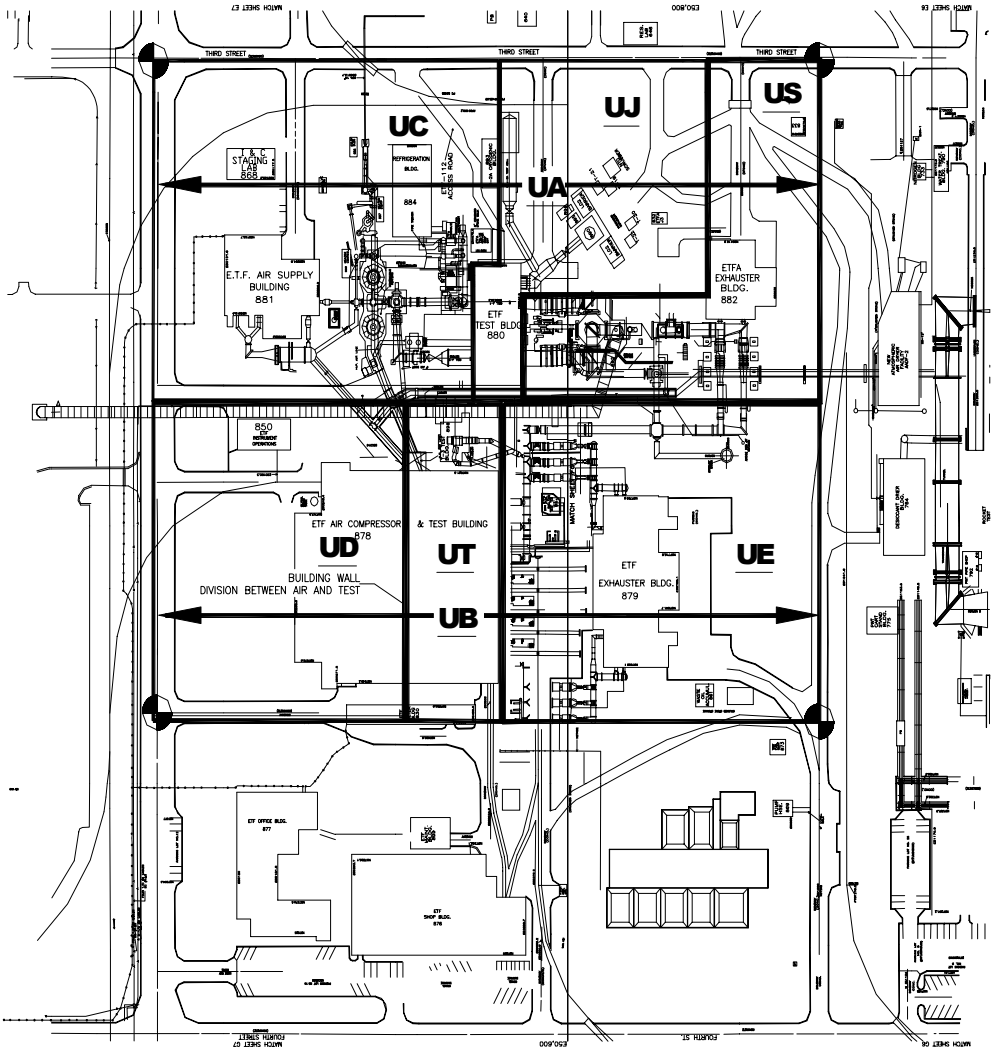


Figure 8.5.1

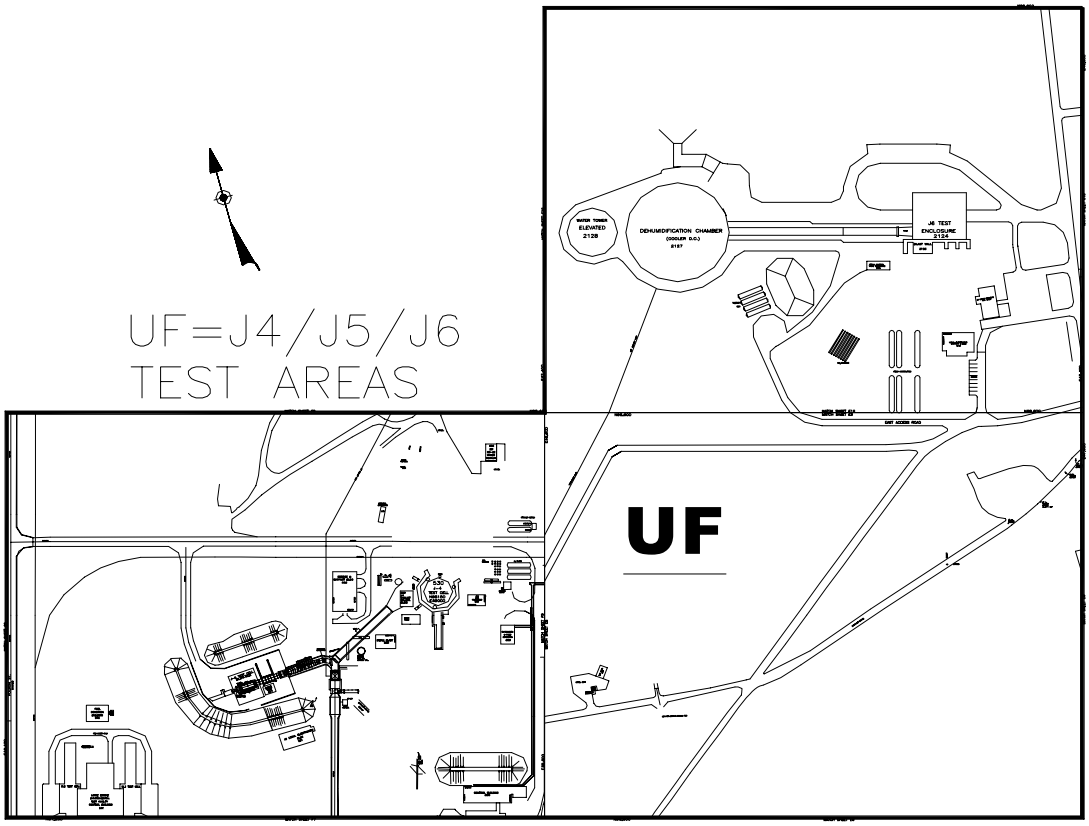


Figure 8.5.2.

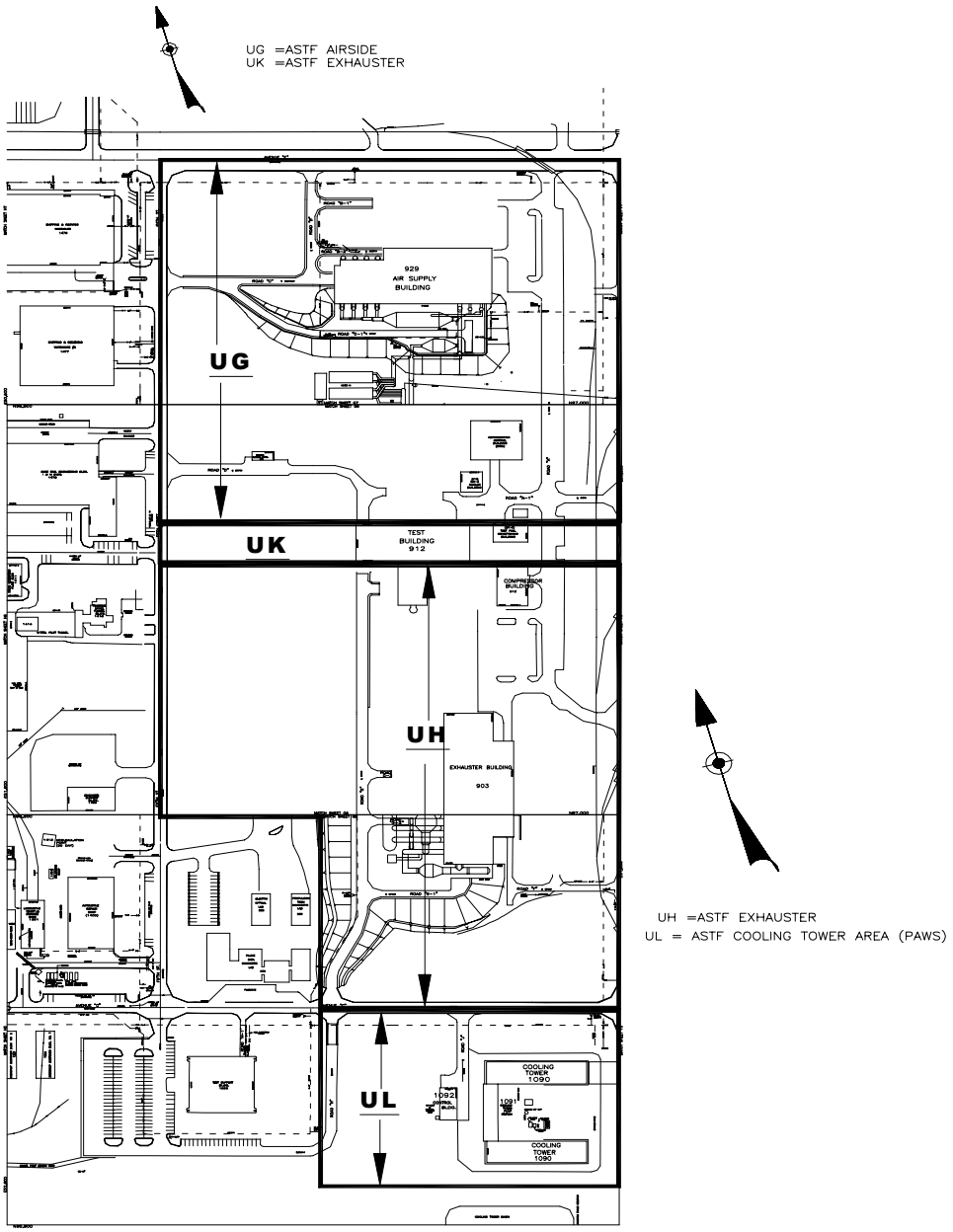
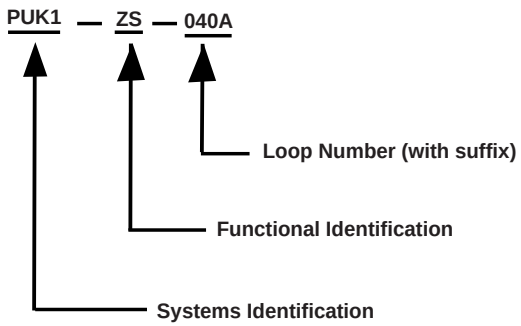

UG =ASTF AIRSIDE
UK =ASTF EXHAUSTER
929
AIR SUPPLY
BUILDING
UG
UK
TEST
BUILDING
912
UH
EXHAUSTER BUILDING
903
UL
COOLING
TOWER
1090
1092
COOLING
TOWER
1090
UH =ASTF EXHAUSTER
UL = ASTF COOLING TOWER AREA (PAWS)

Figure 8.5.3.

8.5.2 **PWT Instrumentation & Equipment** – The following system location codes have historically been used in the areas noted (used exclusively for mechanical devices). They can be used today to maintain consistency; however, for major shsytem modifications, consideration should be given to using the AEDC Standard.



Examples of possible PWT System Identifiers:

PUPESA – PES A Unit
PUPESB – PES B Unit
PUPESC – PES C Unit
PUPESD – PES D Unit
PUPESE – PES E Unit
PUPESF – PES F Unit
PUPESS – PES Supervisory Controller
PU16TTEC – PWT Test Environment Controller
PUMNDR – PWT Main Drive
PU16TNOZ – PWT 16T Nozzle
PU16TDUF – PWT 16T Diffuser
PUK1 – PWT K1 Cooler
PUDRY1 – PWT Atmospheric Drier 1
PUDRY2 – PWT Atmospheric Drier 2

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9.0 PIPING DRAFTING STANDARDS

9.1 PURPOSE

The purpose of this standard is to establish engineering drafting requirements for piping schematics (diagrams) and piping drawings for all new process piping systems and revisions to existing systems to be constructed by or for AEDC.

9.2 SCOPE

This standard covers all process piping systems at AEDC. It defines the device identification, line identification, and other symbolism to be used. Graphical symbols for piping systems shall be in accordance with the following standards.

a. Graphical symbols for process flow diagrams – ASME Y32.11

b. Graphical symbols for pipe fittings, valves and piping –ASME Y32.2.3

c. Graphic symbols for fluid power diagrams-ASME-Y32.10

d. Graphical symbols for heating, ventilating, and air conditioning - ASME Y32.2.4

e. Graphical symbols for heat-power apparatus—ASME Y32.2.6

f. Graphic symbols for plumbing fixtures for diagrams used in architecture and building construction-ASME Y32.4

g. Standard for fire safety symbols-NFPA-170

h. Abbreviations and acronyms-ASME Y14.38

9.3 DEFINITIONS

9.3.1 **Piping system** - Any system conveying fluids (liquid, gas, and slurry) in pipe or tubing at any pressure.

9.3.2 **Piping schematic** - A one-line diagram of a piping system, which shows all system devices necessary for the operation of the system. Piping system drawings/schematics shall be prepared in accordance with each Support Contractor's in-house procedures with design strictly in compliance with AEDC Engineering Standards T-1 Pressure Vessels and T-2 Pressure Piping, as applicable.

9.3.3 **Piping Schematic Suitable for Installation** - A piping schematic which clearly defines all material, including devices, piping, fittings, supports, and code requirements necessary to purchase material, build, and test the system. Spatial dimensions are normally not required but the relative location of devices, branch connections, and the like shall be clearly defined.

9.3.4 Process piping systems refer to all piping systems at AEDC, except those listed below:

a. Fluid Power Systems - ASME Y32.10

b. Heating Ventilation, and Air Conditioning - ASME Y32.2.4

c. Heat Power Apparatus - ASME Y32.2.6

d. Plumbing - ASME Y32.4

e. Fire Protection - NFPA 170

9.3.5 **Mechanical Piping Drawing** - A drawing showing piping and associated equipment, physical location, orientation, dimensions, material specification, and all information necessary for fabrication, installation, and testing.

9.3.6 **Device** - Any valve, regulator, pump, flex hose, flow-meter, gauge, pressure vessel, relief or other mechanical, electrical, pneumatic, or hydraulic piece of equipment used in conveying, containing, measuring, sensing, or regulating fluids in a piping system.

9.4 GENERAL REQUIREMENTS

9.4.1 Mechanical piping drawings or piping schematics suitable for installation purpose shall be prepared for all piping systems involving line sizes larger than 2 in. or line sizes 2 in. and smaller conveying fluids at pressures greater than 150 psig , and for all piping systems conveying toxic or hazardous fluids at any pressure.

9.4.2 The design activity (AEDC Support Contractor, AE, or outside contractor) that prepares the installation drawings shall also prepare a piping system bill of material for each mechanical piping drawing or installation as required in 9.4.1.

9.4.3 Relief valve settings and hydrostatic and / or pneumatic test conditions shall be specified on the drawing.

9.4.4 All piping system schematics (diagrams) which are to be incorporated within the permanent filing system must be numbered with standard drawing numbers in accordance with Section 4.0 (no sketch numbers).

9.4.5 Typical drawing notes are shown in 6.0. Applicable notes may be selected and included as required. Variations of the suggested typical notes or additional notes may be necessary to properly describe engineering design requirements. However, do not use notes to include requirements that belong in an acquisition specification.

9.4.6 Permanent process piping systems, which cannot be defined adequately on a schematic piping diagram, must be incorporated as mechanical piping drawings and must conform to the applicable schematic.

9.4.7 Drawings prepared for use at AEDC shall conform to applicable sections of this standard. Applicable sections of this standard may be referenced and included in outside procurement specifications. However, the preferred procedure is to cite the specific standard on which the AEDC requirement is based and list other requirements, such as those peculiar to AEDC, in the specification.

9.4.8 The system maximum design conditions (pressure and temperature) shall be shown along each major section of line where it applies or where it changes, or as zones in the general notes.

9.4.9 As-built and operational drawings and schematics of piping shall include the pressure system device list in the format shown in Figure 9.6 on page 9-20.

9.4.10 Piping systems shall be identified based on the requirements of AEDC Safety Standard D3.

9.5 SCHEMATIC PIPING DIAGRAMS

9.5.1 **Device Identification-** All devices shall be identified on schematic (diagrams) with a unique Alphanumeric "Device Name" (see Section 8.0-Device Identification)

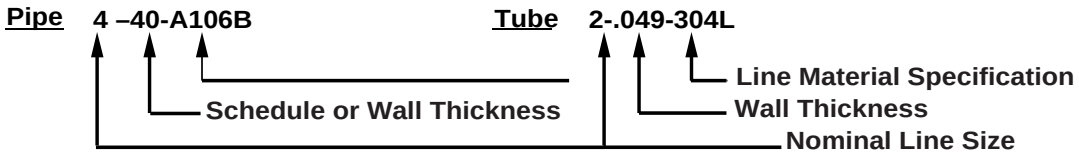
9.5.2 **Line Identification –** All pipe or tube lines are to be identified on process flow schematics (diagrams) according to the following:

a. Line size (nominal)

b. Line schedule or wall thickness

c. Line material specification

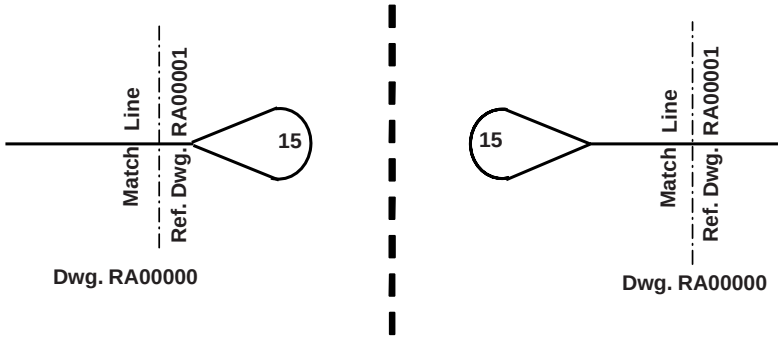
Examples:



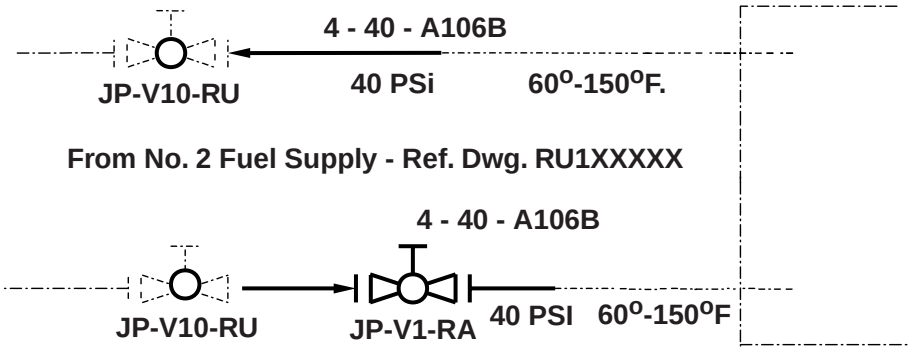
Note: Include complete material specification and schedule for all piping and tubing either as shown or in the general notes.

9.5.3 **Line Terminals –** Where more than one drawing is required for a particular piping system flow schematic (diagram), either tear drop bubbles, with matching numerals, shall be used to identify line numbers at match lines between drawings, or interface information, including drawing number, line pressure, and nearest major device shall be included at the termination point(s).

Example:



OR



9.5.4 **Legend Symbols –** All piping systems shall include a list of symbols for all devices or Services not listed as standard in this manual.

9.5.5 **Schematic Symbols** - Menus for AutoCAD R14 and AutoCad 2000 are available and are maintained on WCsr003\apps\pidsym\symlib2. AutoCAD R14 menus are menu7 (process) and menu8(fluid). AutoCAD 2000 menus are menu9(proess) and menu10 (flluid).

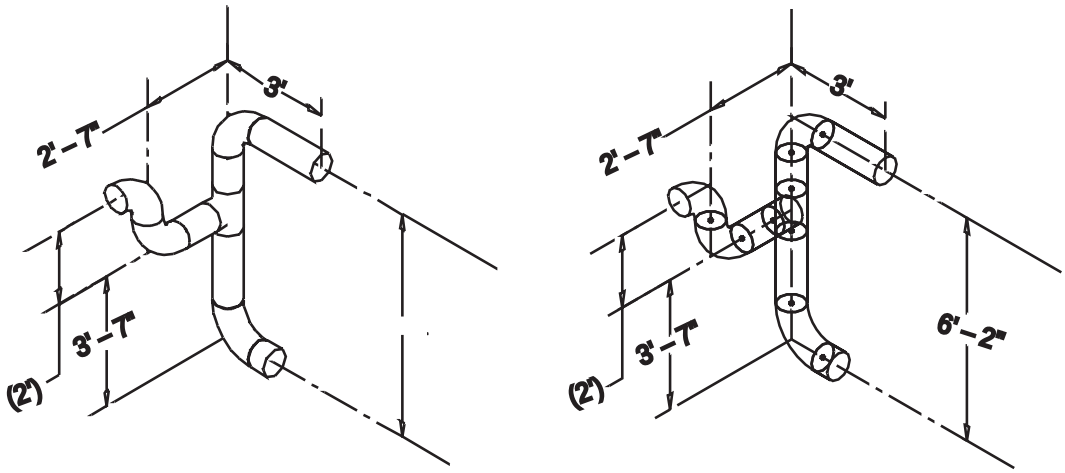
9.6 MECHANICAL PIPING DRAWINGS

9.6.1 **Application -** Mechanical Piping Drawings are appropriate for any process piping installation and are mandatory for any system containing hazardous fluid.

9.6.2 **Device and Line Size Identification –** The process used for identifying devices and line sizes on mechanical installation drawings shall be the same as that shown in Section 9.5.1.

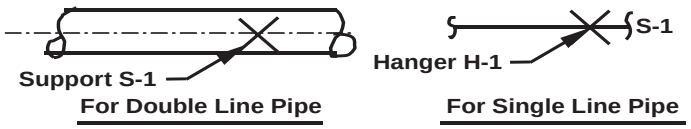
9.6.3 **Single and Double Line Piping and 3D-** Mechanical piping may be drawn either single line or double line or 3D , suggested scales are as follows:
(Note: scales may be larger or smaller depending on the need for clarity)

Scale of Drawing	Piping Shown on Drawing	
	Single Line	Double Line
1/8” = 1’-0”	6” & Smaller	8” & Larger
3/16” = 1’-0”	4” & Smaller	6” & Larger
1/4” = 1’-0”	3” & Smaller	4” & Larger
3/8” = 1’-0”	2” & Smaller	2 - 1/2” & Larger
1/2” = 1’-0”	1 – 1/2” & Smaller	2” & Larger
3/4” = 1’-0” & Larger	1” & Smaller	1 – 1/2” & Larger

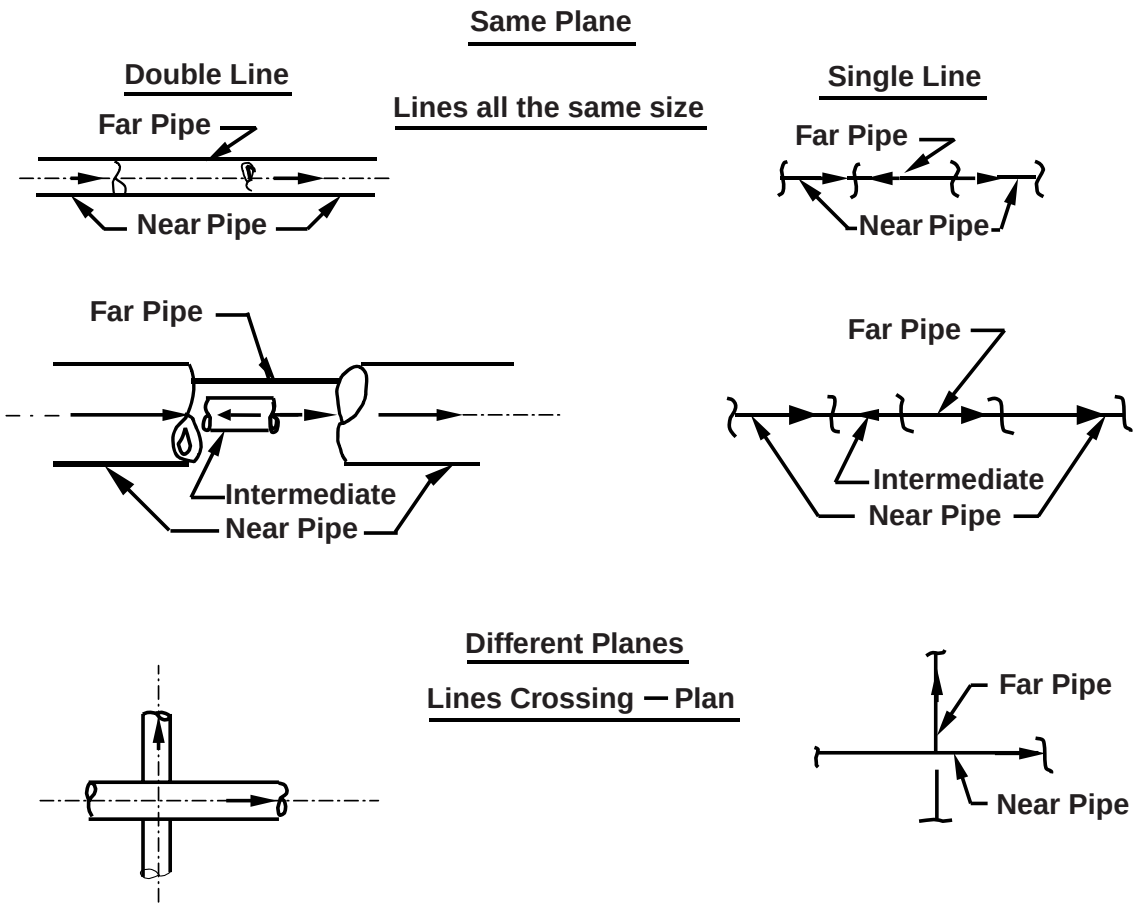


Three Dimensional

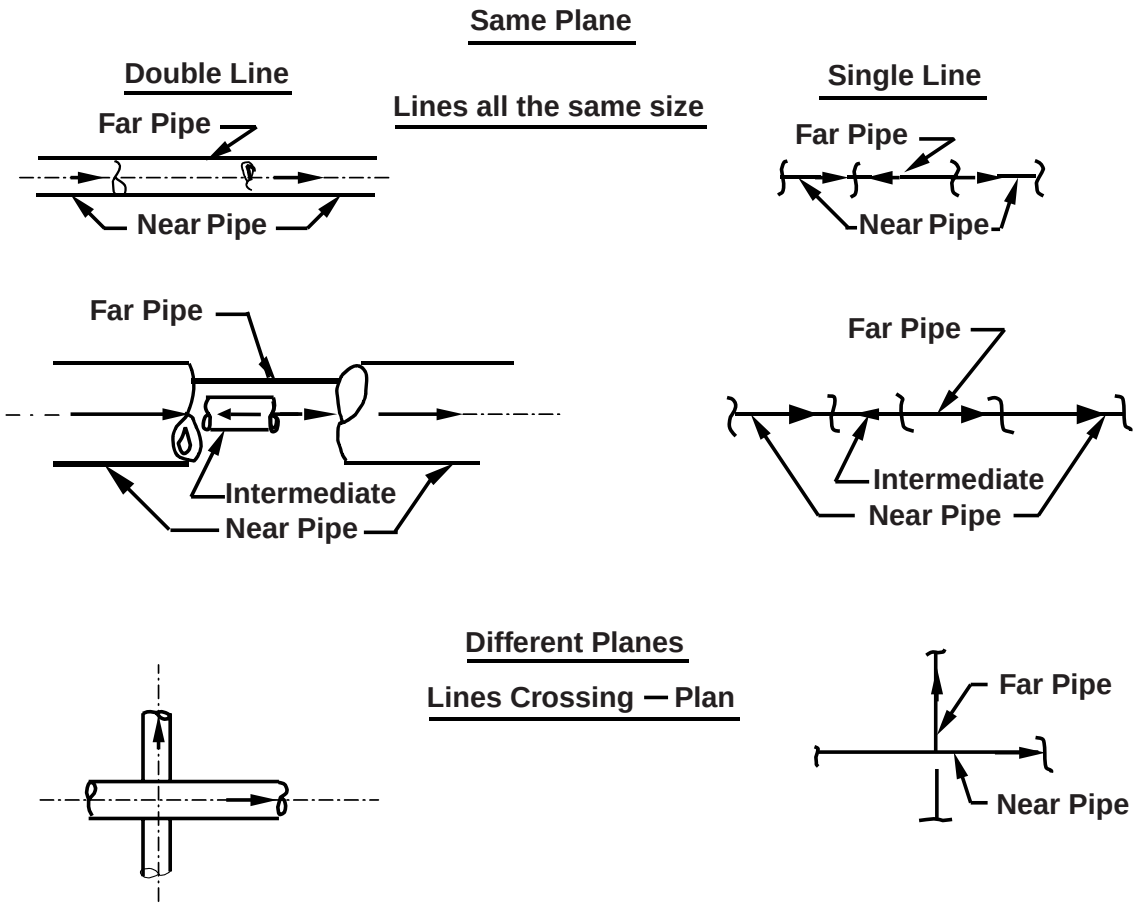
Support and hangers may be shown to scale or may tabulated and depicted as follows:



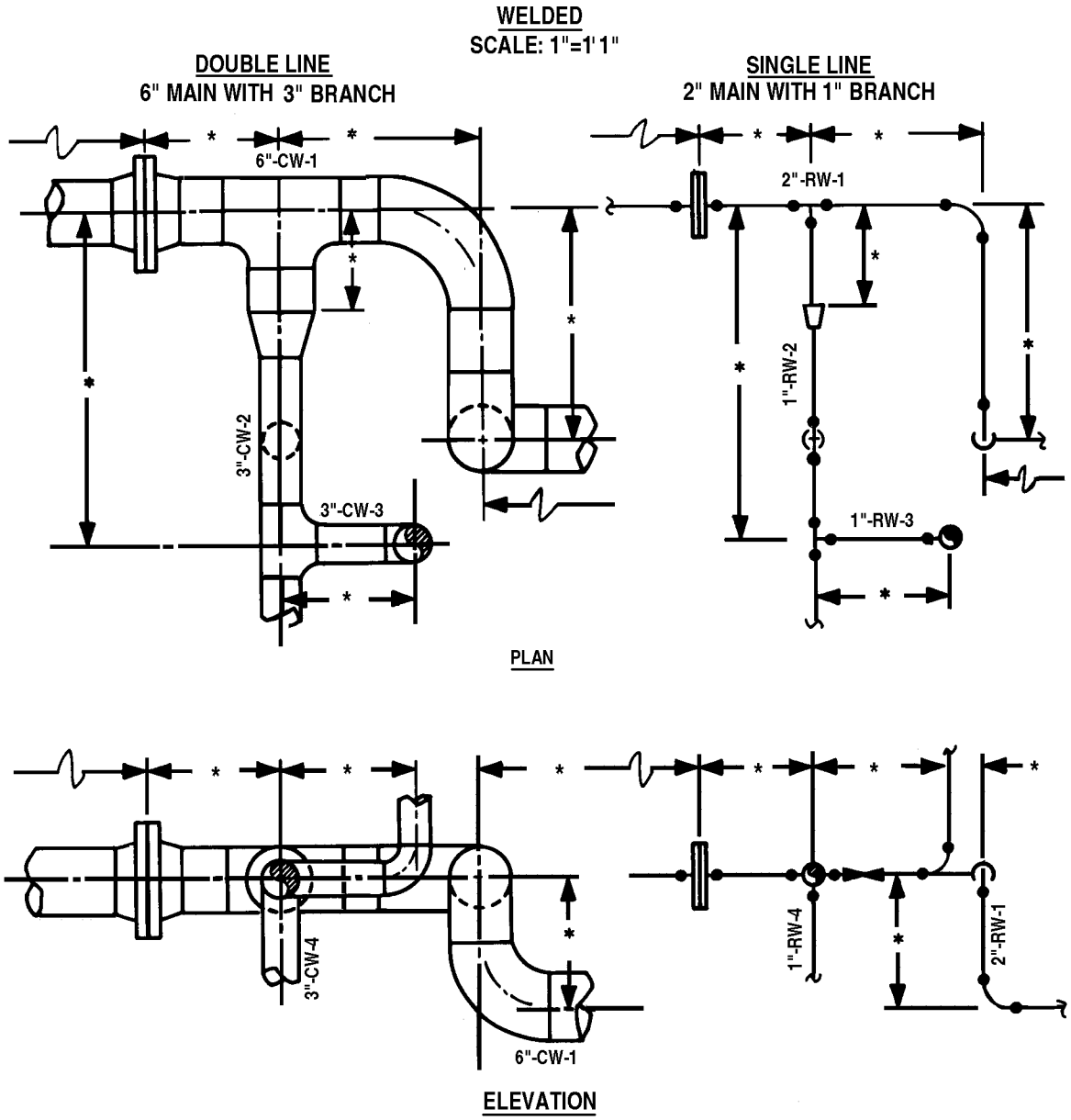
SUPPORTS	
	U- bolt
H-1	Hanger


Same Plane
Double Line
Lines all the same size
Single Line
Far Pipe
Near Pipe
Far Pipe
Near Pipe
Far Pipe
Intermediate
Near Pipe
Far Pipe
Intermediate
Near Pipe
Different Planes
Lines Crossing — Plan
Far Pipe
Near Pipe

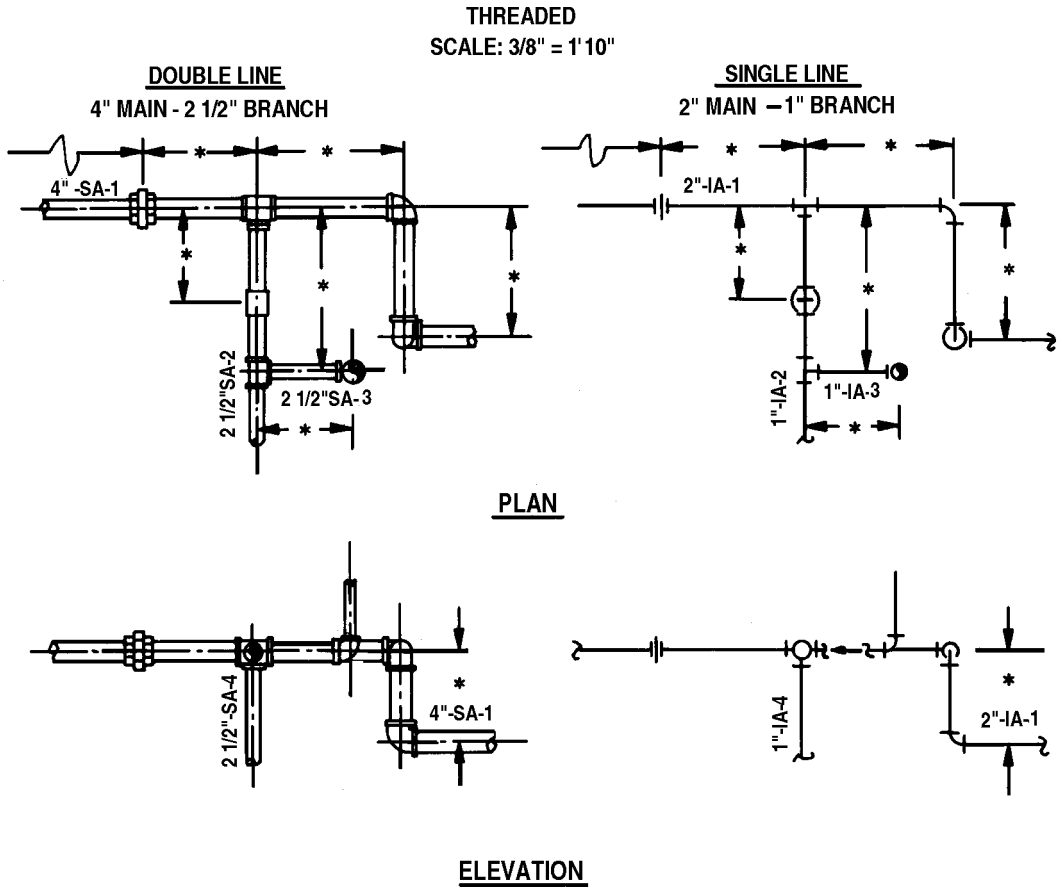
9.6.4 **Grouped Piping:**



9.6.4 **Typical Mechanical Piping Arrangements:**



*INDICATE SCALED DIMENSIONS IN FEET AND INCHES
E.G., 5'-6", 2'-1 1/2", 0'-3", 109'-0", ETC.



9.6.5 **Dimensioning Piping Assemblies:**

a. Dimensioning — Piping is normally of a circular cross section. Thus, the geometry of a piping system can be fully defined by the location of the centerline axis of the pipe. Terminal points and points of change in direction of the pipe axis are known as working points. Since two points determine a straight line, it is recommended that the pipe axes be located by means of working points. Two alternate methods of locating working points are suggested in Figures 9.1(a) and 9.1(b). Figure 9.1(a) illustrates location of the working points along the axis of the pipe by providing information on the length and direction of each consecutive segment of the axis. Figure 9.1(b) illustrates dimensioning by means of location of the working points from fixed reference planes, such as from ground elevation and column lines. While not necessary for the determination of the pipeline geometry, it is essential that the following additional information also be provided to completely define the fabrication requirements.

1. Radius of bend
2. Type of elbow
3. Gasket or other allowances
4. Pipe size and wall thickness
5. Method of intersection, such as tee or nozzle
6. Location of flanged or field welded joints
7. Location of attachments
8. Permissible tolerances
9. Material.

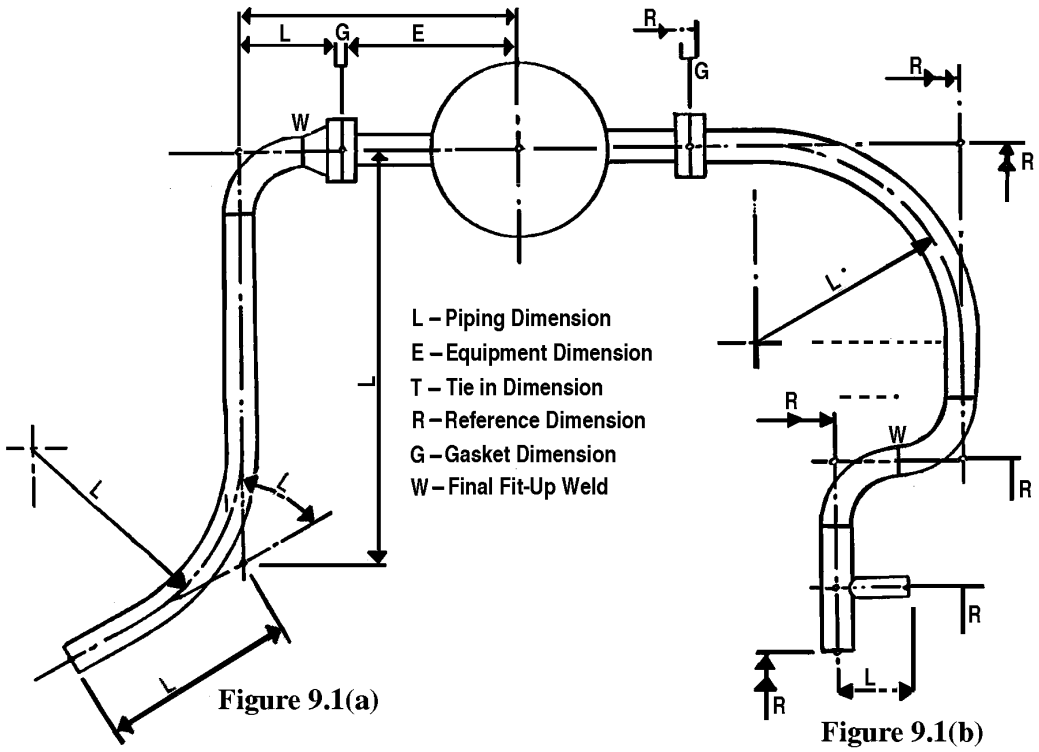


Figure 9.1(a)

Figure 9.1(b)

Figure 9.1 Dimensioning Methods

b. Fabrication Variables and Tolerances—In joining the components of a fabricated assembly, consideration by the fabricator must be given to three primary factors: weld spacing, shrinkage, and fitting tolerance.

In order to assure full penetration to the root of a weld, the ends to be jointed are set up with a small gap between them called root spacing. This root spacing may vary from 0 to 1/4" depending on the welding technique employed and the piping materials. In welds marked "W" in Fig. 9.1(a) and 9.1(b), it may be necessary to vary root spacing, select parts or, if necessary, trim a component to produce overall required dimensions.

Shrinkage of the weld metal occurs in cooling. This shrinkage varies with welding process, technique, piping material, and pipe wall thickness. On steel, the weld shrinkage usually amounts to 1/16" to 1/8". Consequently, allowances must be made for shrinkage.

All standard welding fittings and flanges are subject to tolerances on terminal dimensions (End to End, Face to End, End to Center, etc.) The tolerance on overall length of flanges is given in ANSI B16.5. It is 1/16" for sizes up to and including 10" and 1/8" for larger sizes. ANSI B16.9 gives tolerances for welding fittings. These are 1/16" for sizes up to and including 8" and 3/32" for larger sizes. These tolerances apply to center-to-end dimensions of tees and 45 and 90 degree elbows and to the overall dimensions of lap joint stud ends. Figure 9.2 and Table 9.1 illustrate the application of fabrication tolerances to the face to face, face to end, and end measurements of fabricated straight pipe and headers; center to center, center to end, or center to face of nozzles or other attachments; and end to end, face to face, center to end, or center to face of bends.

The above mentioned variables are beyond the control of the engineering designer. Allowances for weld gap should not be included on engineering drawings. Overall dimensions of close assemblies of fittings or fittings and flanges should be determined on the basis of the net sum of the nominal dimensions of the component parts.

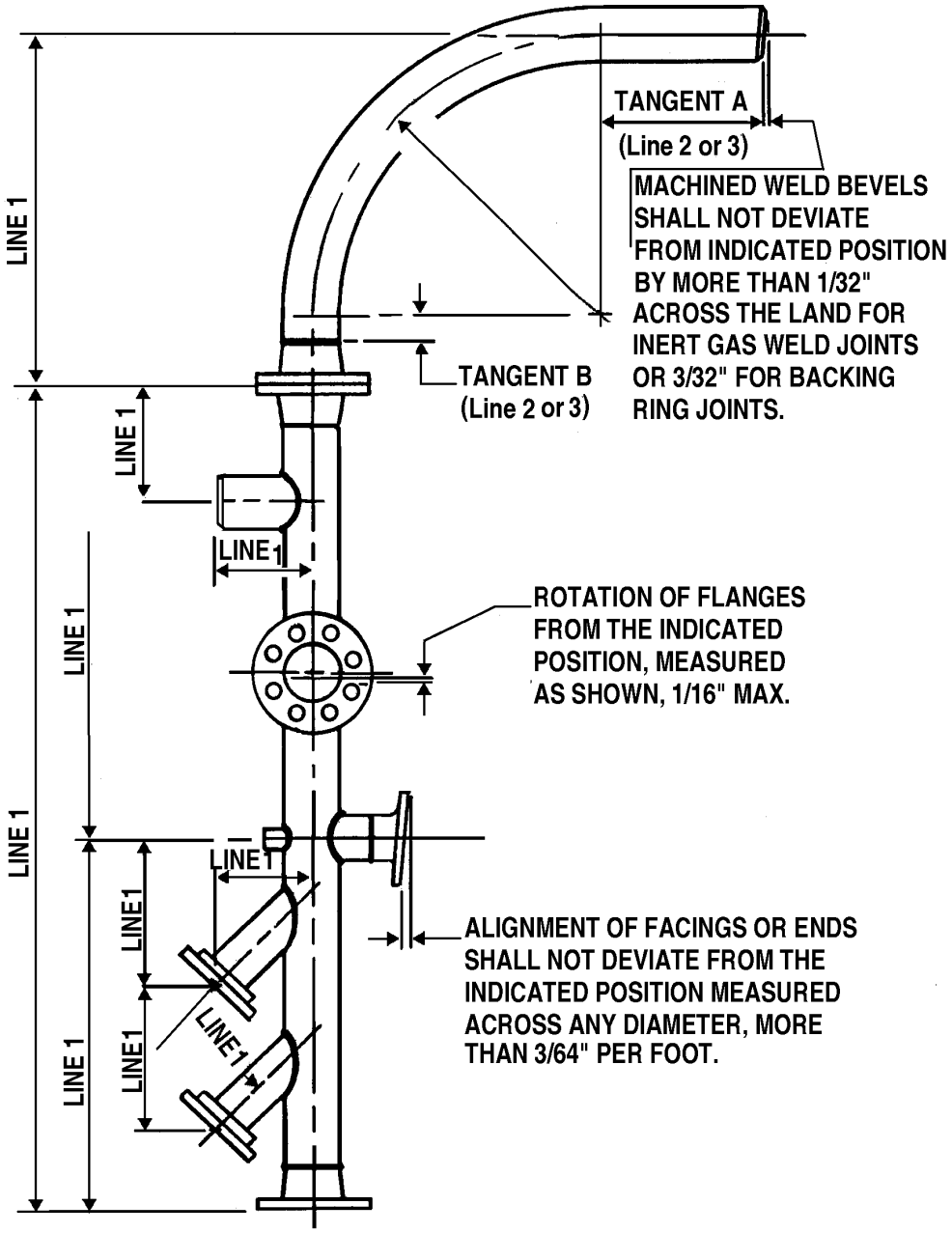


Figure 9.2 Application of Pipe Fabrication Tolerances (Refer to Table 9.1 for Line References).
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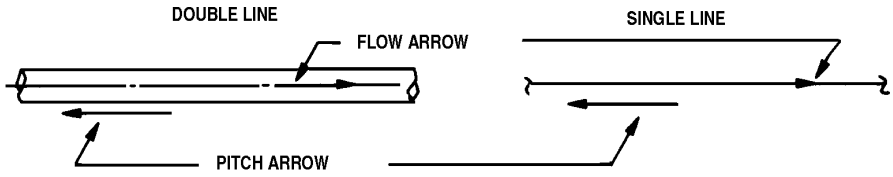
Table 9.1 Minimum Tangent and Linear Tolerances

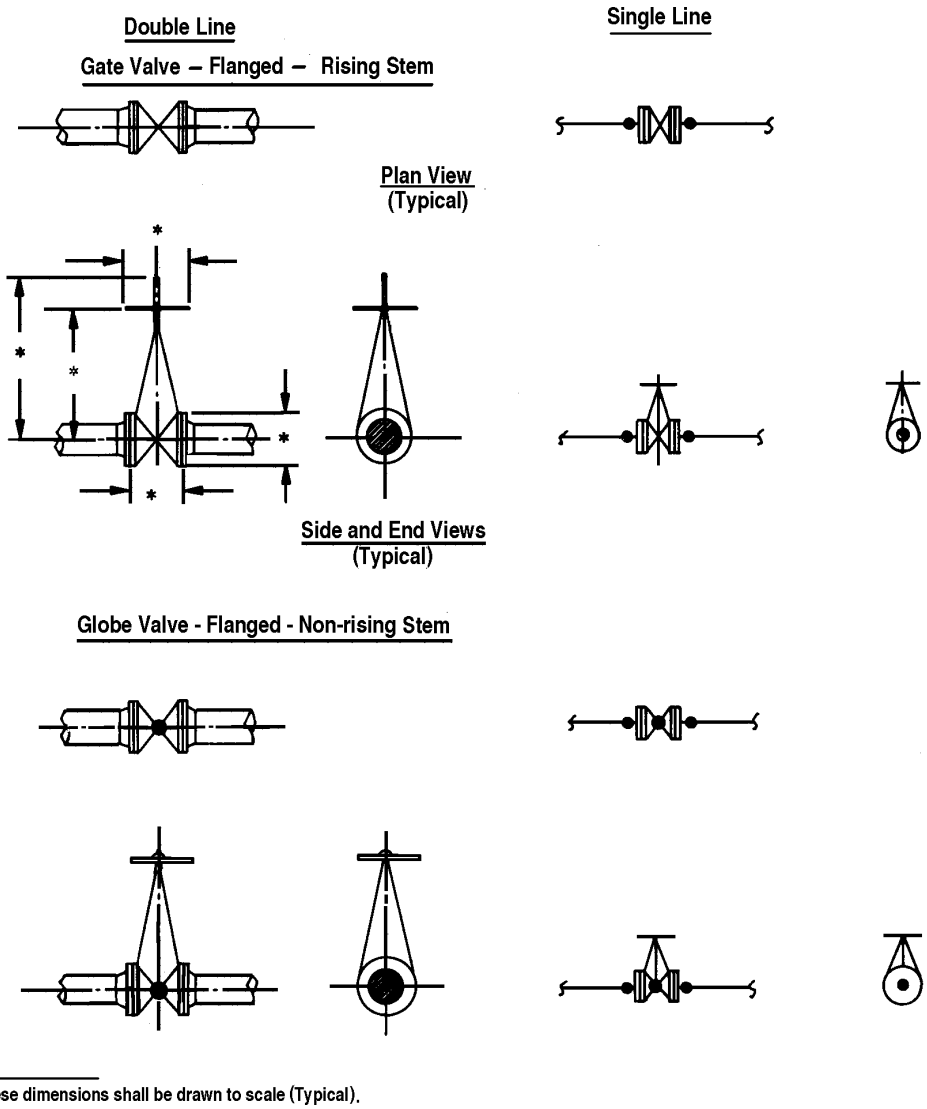
Nom. Pipe, Size, Inches	1	1 1/4	1 1/2	2	2 1/2	3	3 1/2	4	5	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36
Min. Holding End, In. for all Walls and Min. Pulling End for Min. Walls over 1 1/2" (2)	6	6	6	6	8	8	8	10	10	12	16	20	24	28	32	36	40	44	48	52	56	60	64	68	72
Min. Pulling End, In. for Min. Walls 1 1/2" and under (3)	6	6	6	6	8	8	8	10	10	10	12	15	18	21	24	27	30	33	36	42	42	45	48	51	54
Tolerances--Inches (1)																									
end to end	± 1/8"																			± 1/8"					
end to face																									
face to face																									
center to end																									
center to face																									
center to center																									

References (1), (2), and (3) are for use in conjunction with Figure 9.2.

9.6.6 Method of Depicting Flow Arrow & Pitch (Slope) Arrow:

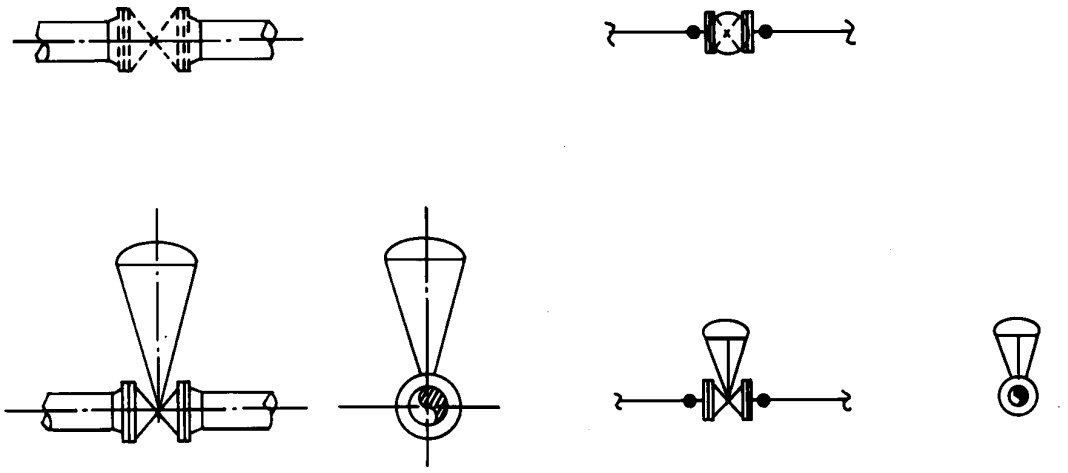


9.6.7 Method of Depicting Valves:

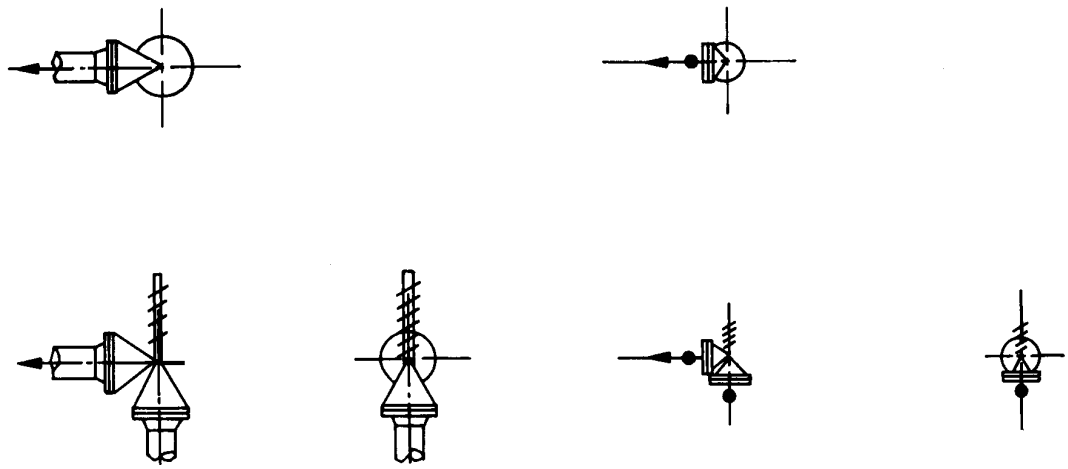


*These dimensions shall be drawn to scale (Typical).

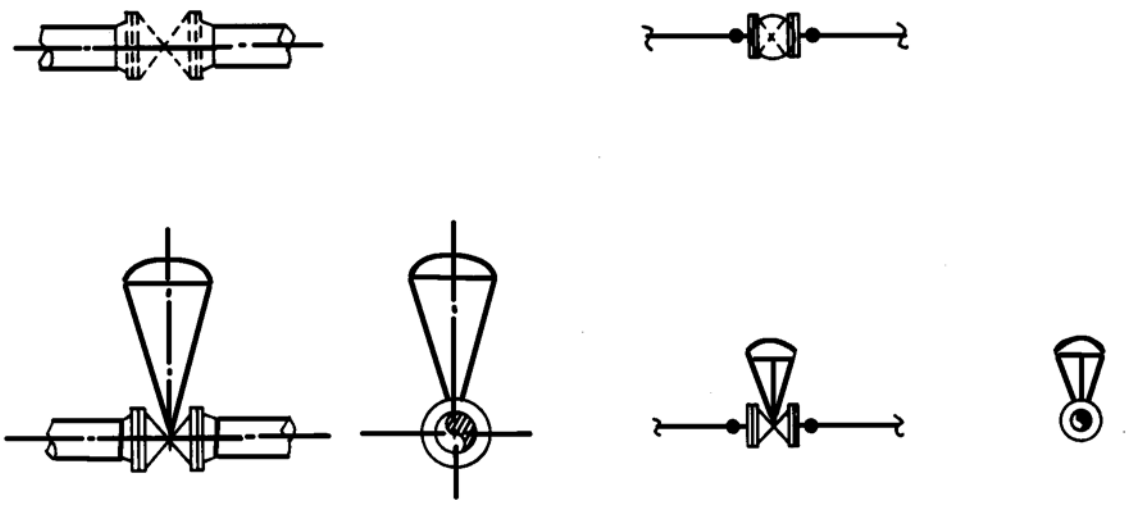
Control Valve - Flanged - (PCV, TCV, FCV)



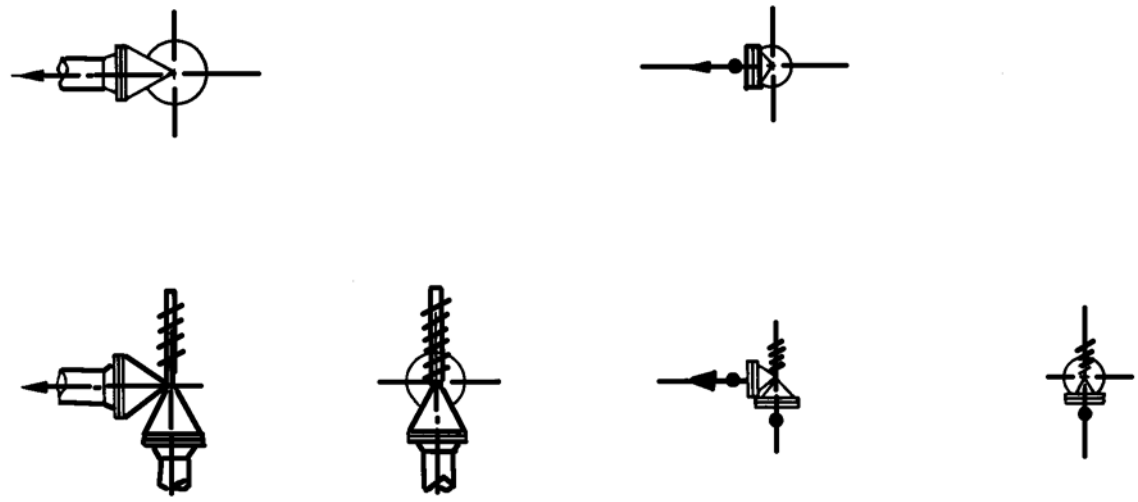
Relief Valve - Flanged - Angle



Control Valve - Flanged - (PCV, TCV, FCV)



Relief Valve - Flanged - Angle



Other valves and devices will be similarily depicted to the simplest possible manner to respresnet as closely as possible actual configuration.

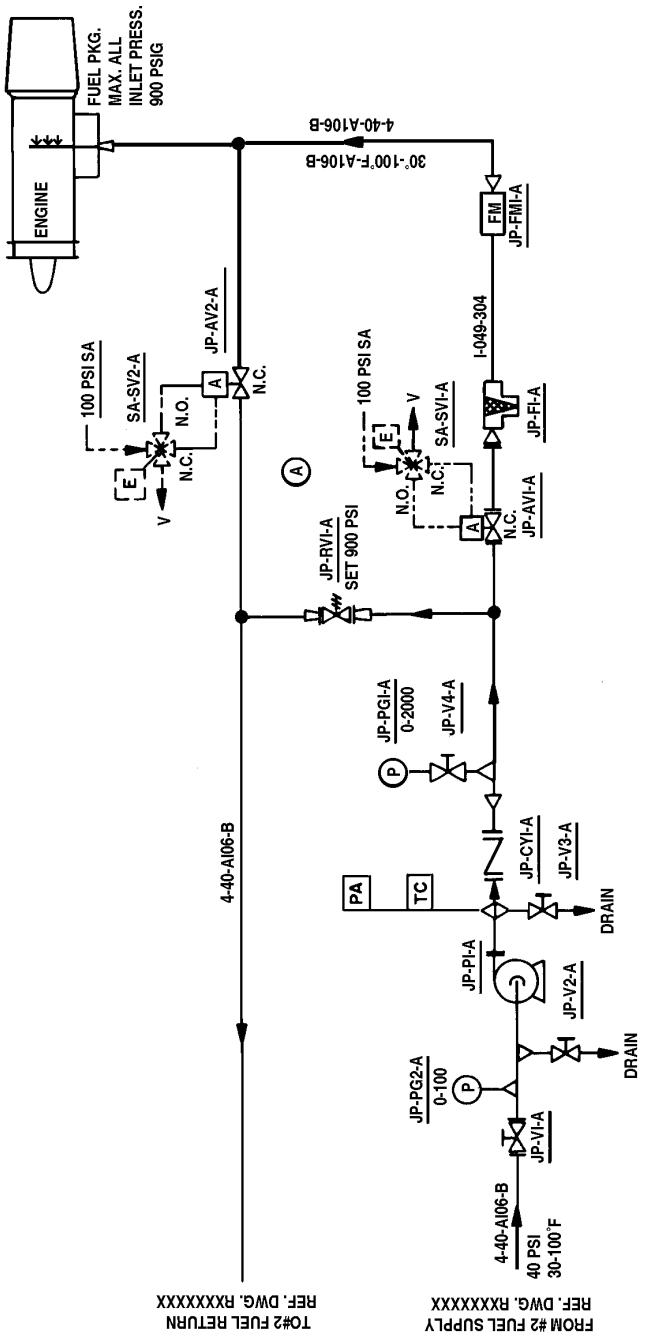
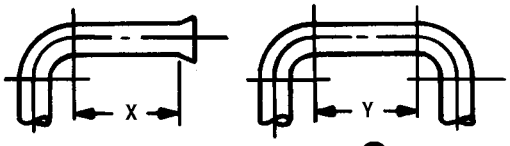


Figure 9.3 Typical Schematic Piping Diagram

SIZE O. D.	MAX. WALL*	CENTERLINE BEND RADIUS**	MINIMUM STRAIGHT LENGTH FLARE TO CURVE ("X") BETWEEN CURVES ("Y")	
				
1/4	.049	9/16 Ⓗ, 3/4	1-3/16	1/2 Ⓗ, 1
5/16	.065	11/16 Ⓗ, 1	1-3/16	1/2 Ⓗ, 1
3/8	.083	15/16 Ⓗ, 1-1/4	1-1/4	1/2 Ⓗ, 1
1/2	.083	1-1/2 Ⓗ, 2, 3	1-5/16	1
5/8	.083	2-1/2	1-3/8	1
3/4	.083	3, 4	1-7/16	1-1/4
1	.095	4, 6	2-5/16	1-1/4
1-1/8	.095	4-1/2	2-3/8	3-1/2 ***
1-1/4	.095	5, 6	2-7/16	2 ***
1-1/2		5	2-5/8	4-1/2
2		8	2-11/16	4-1/2

*Mandrels are required for perfect for perfect bends in thin wall tubing.

Mandrels on hand: 1-1/2 O. D. × .035 wall
2 O. D. × .035 wall
2 O. D. × .035 wall

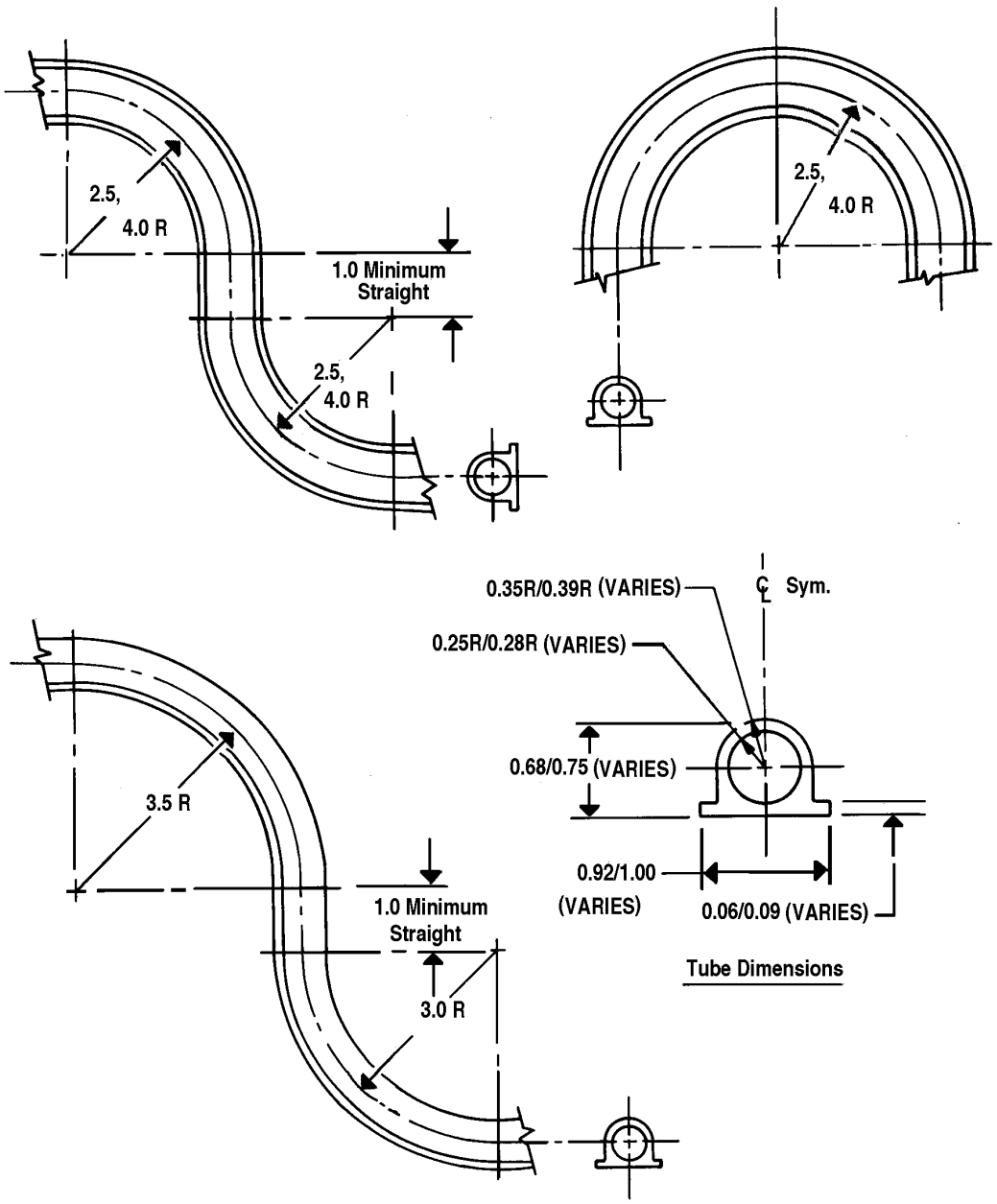
** Other Radii can be bent if User purchases special blocks and mandrels.

*** Dictated by size of mandrels on hand.

Ⓗ Hand Bender Only. Limited to thinner walls on hard material.

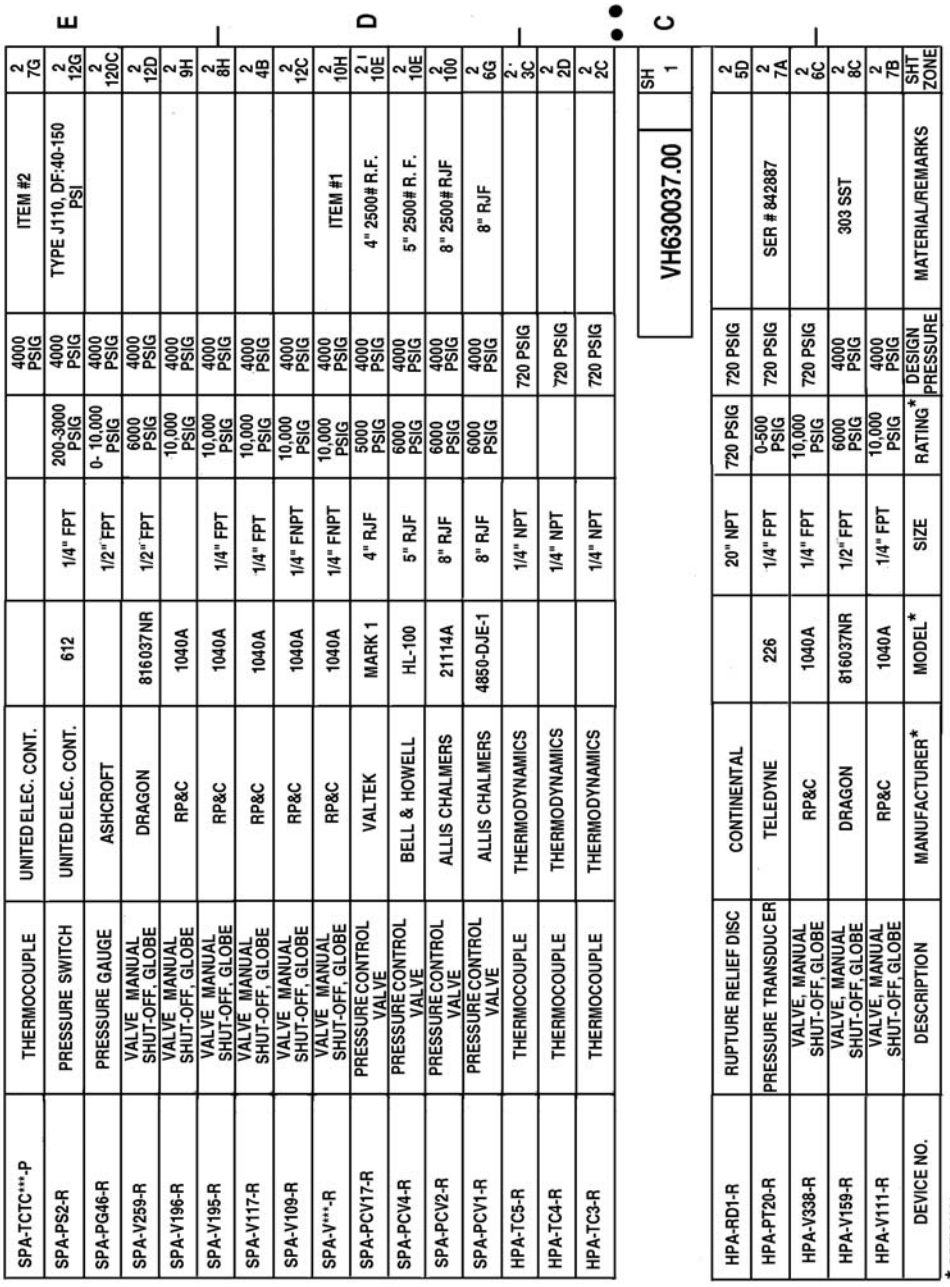
NOTE: Table information was obtained from Contractor C Pipe Shop on available tools and physical requirements for tube bending. The Designer is referred to AEDC-ENGR-STD-2 for proper allowances to make for wall thinning during bending.

Figure 9.4 Preferred Tube Bends



NOTE: Dimensions given are for nominal 1/2" I. D. tube. Bend radii are based on mandrels on hand.

Figure 9.5 Aluminum "D" Tube Dimensions and Standard Bends



SPA-TCTC***-P	THERMOCOUPLE	UNITED ELEC. CONT.				4000 PSIG	ITEM #2	2 7G
SPA-PS2-R	PRESSURE SWITCH	UNITED ELEC. CONT.	612	1/4" FPT	200-3000 PSIG	4000 PSIG	TYPE J110, DF:40-150 PSI	2 12G
SPA-PG46-R	PRESSURE GAUGE	ASHCROFT		1/2" FPT	0- 10,000 PSIG	4000 PSIG		2 120C
SPA-V259-R	VALVE MANUAL SHUT-OFF, GLOBE	DRAGON	816037NR	1/2" FPT	6000 PSIG	4000 PSIG		2 12D
SPA-V196-R	VALVE MANUAL SHUT-OFF, GLOBE	RP&C	1040A		10,000 PSIG	4000 PSIG		2 9H
SPA-V195-R	VALVE MANUAL SHUT-OFF, GLOBE	RP&C	1040A	1/4" FPT	10,000 PSIG	4000 PSIG		2 8H
SPA-V117-R	VALVE MANUAL SHUT-OFF, GLOBE	RP&C	1040A	1/4" FPT	10,000 PSIG	4000 PSIG		2 4B
SPA-V109-R	VALVE MANUAL SHUT-OFF, GLOBE	RP&C	1040A	1/4" FNPT	10,000 PSIG	4000 PSIG		2 12C
SPA-V***-R	VALVE MANUAL SHUT-OFF, GLOBE	RP&C	1040A	1/4" FNPT	10,000 PSIG	4000 PSIG	ITEM #1	2 10H
SPA-PCV17-R	PRESSURE CONTROL VALVE	VALTEK	MARK 1	4" RJF	5000 PSIG	4000 PSIG	4" 2500# R.F.	2 1 10E
SPA-PCV4-R	PRESSURE CONTROL VALVE	BELL & HOWELL	HL-100	5" RJF	6000 PSIG	4000 PSIG	5" 2500# R. F.	2 10E
SPA-PCV2-R	PRESSURE CONTROL VALVE	ALLIS CHALMERS	21114A	8" RJF	6000 PSIG	4000 PSIG	8" 2500# RJF	2 10D
SPA-PCV1-R	PRESSURE CONTROL VALVE	ALLIS CHALMERS	4850-DJE-1	8" RJF	6000 PSIG	4000 PSIG	8" RJF	2 6G
HPA-TC5-R	THERMOCOUPLE	THERMODYNAMICS		1/4" NPT		720 PSIG		2 3C
HPA-TC4-R	THERMOCOUPLE	THERMODYNAMICS		1/4" NPT		720 PSIG		2 2D
HPA-TC3-R	THERMOCOUPLE	THERMODYNAMICS		1/4" NPT		720 PSIG		2 2C

VH630037.00 SH 1

HPA-RD1-R	RUPTURE RELIEF DISC	CONTINENTAL		20" NPT	720 PSIG	720 PSIG		2 5D
HPA-PT20-R	PRESSURE TRANSDUCER	TELEDYNE	226	1/4" FPT	0-500 PSIG	720 PSIG	SER # 842887	2 7A
HPA-V338-R	VALVE, MANUAL SHUT-OFF, GLOBE	RP&C	1040A	1/4" FPT	10,000 PSIG	720 PSIG		2 6C
HPA-V159-R	VALVE, MANUAL SHUT-OFF, GLOBE	DRAGON	816037NR	1/2" FPT	6000 PSIG	4000 PSIG	303 SST	2 8C
HPA-V111-R	VALVE, MANUAL SHUT-OFF, GLOBE	RP&C	1040A	1/4" FPT	10,000 PSIG	4000 PSIG		2 7B
DEVICE NO.	DESCRIPTION	MANUFACTURER*	MODEL*	SIZE	RATING*	DESIGN PRESSURE	MATERIAL/REMARKS	SHT ZONE

* OPTIONAL

Figure 9.6 Pressure System Device List

Table 9.2 Standard Device Symbols

The symbols below are basic and are minimum requirements. They are either identical to, substitutes for, or additional to those represented in ANSI ASA Z32.2.3. Special valves, if not identified below and absolutely required, may be represented by including them on the drawing as legend symbols.

PROCESS PIPING

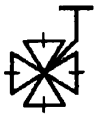
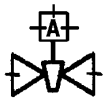
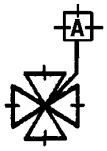
Device Name (Code)	Process Piping Device Symbol / CAD/CAM Symbol Name					
	GLOBE OR PLUG	GATE	BALL	COCK	BUTTERFLY	3 & 4 WAY
Manual Shut-Off Valve (V)	 PIV100 GLOBE PIV240 PLUG	 PIV101	 PIV102	 PIV103	 PIV229	 PIV109
	 PIV105 GLOBE PIV241 PLUG	 PIV106	 PIV107	 PIV108		 PIV109
Air-Operated Valve (AV)	GLOBE OR PLUG	GATE	BALL	COCK	BUTTERFLY	3 & 4 WAY
	 PIV110 GLOBE PIV242 PLUG	 PIV111	 PIV112	 PIV113	 PIV230	 PIV114
	 PIV115 GLOBE PIV243 PLUG	 PIV116	 PIV117	 PIV118		 PIV119

Table 9.2. Continued

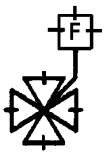
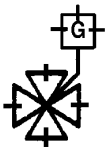
Device Name (Code)	Process Piping Device Symbol CAD/CAM Symbol Name					
	GLOBE OR PLUG	GATE	BALL	COCK	BUTTERFLY	3 & 4 WAY
Fluid -Operated Valve (FV)	 PIV120 GLOBE PIV244 PLUG  PIV125 GLOBE PIV245 PLUG	 PIV121  PIV126	 PIV122  PIV127	 PIV123  PIV128	 PIV231	 PIV124  PIV129
Gas-Operated Valve (GV)	GLOBE OR PLUG	GATE	BALL	COCK	BUTTERFLY	3 & 4 WAY
	 PIV130 GLOBE PIV246 PLUG  PIV135 GLOBE PIV247 PLUG	 PIV131  PIV136	 PIV132  PIV137	 PIV133  PIV138	 PIV232	 PIV134  PIV139

Table 9.2 Continued

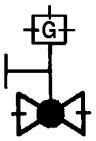
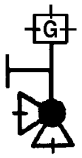
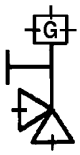
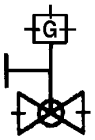
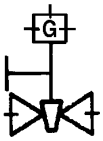
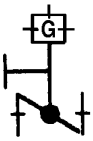
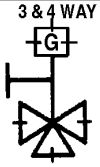
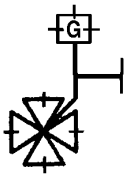
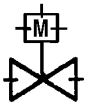
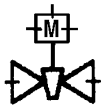
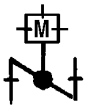
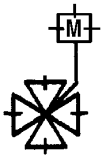
Device Name (Code)	Process Piping Device Symbol / CAD/CAM Symbol Name					
	GLOBE OR PLUG	GATE	BALL	COCK	BUTTERFLY	3 & 4 WAY
Gas/Manual-Operated Valve (GMV)	 PIV140 GLOBE PIV248 PLUG  PIV145 GLOBE PIV249 PLUG	 PIV141  PIV146	 PIV142  PIV147	 PIV143  PIV148	 PIV233	 PIV144  PIV149
Motor-Operated Valve (MV)	GLOBE OR PLUG  PIV150 GLOBE PIV250 PLUG  PIV155 GLOBE PIV251 PLUG	GATE  PIV151  PIV156	BALL  PIV152  PIV157	COCK  PIV153  PIV158	BUTTERFLY  PIV234	3 & 4 WAY  PIV154  PIV159

Table 9.2 Continued

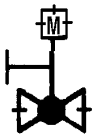
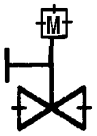
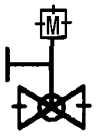
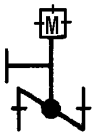
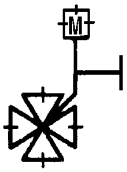
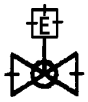
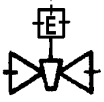
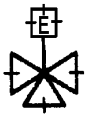
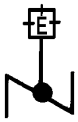
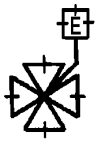
Device Name (Code)	Process Piping Device Symbol CAD/CAM Symbol Name					
Motor/Manual Operated Valve (MMV)	GLOBE OR PLUG  PIV160 GLOBE PIV252 PLUG	GATE  PIV161	BALL  PIV162	COCK  PIV163	BUTTERFLY  PIV235	3 & 4 WAY  PIV164
	 PIV165 GLOBE PIV253 PLUG	 PIV166	 PIV167	 PIV168		 PIV169
Solenoid-Operated Valve (SV)	GLOBE OR PLUG  PIV170 GLOBE PIV254 PLUG	GATE  PIV171	BALL  PIV172	COCK  PIV173	BUTTERFLY	3 & 4 WAY  PIV174
	 PIV175 GLOBE PIV255 PLUG	 PIV176	 PIV177	 PIV178	 PIV236	 PIV179

Table 9.2. Continued

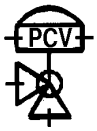
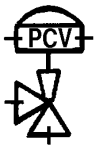
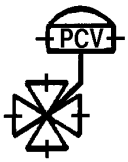
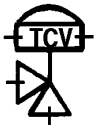
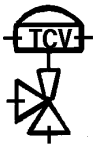
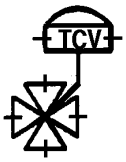
Device Name (Code)	Process Piping Device Symbol / CAD/CAM Symbol Name					
	GLOBE OR PLUG	GATE	BALL	COCK	BUTTERFLY	3 & WAY
Pressure Control Valve (PCV)	 PIV150 GLOBE PIV256 PLUG  PIV165 GLOBE PIV257 PLUG	 PIV181  PIV186	 PIV182  PIV187	 PIV183  PIV188	 PIV237	 PIV154  PIV189
	GLOBE OR PLUG	GATE	BALL	COCK	BUTTERFLY	3 & 4 WAY
Temperature Control Valve (TCV)	 PIV190 GLOBE PIV258  PIV195 GLOBE PIV259 PLUG	 PIV191  PIV196	 PIV192  PIV197	 PIV193  PIV196	 PIV238	 PIV194  PIV199

Table 9.2. Continued

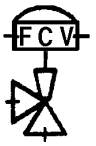
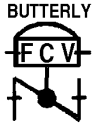
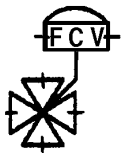
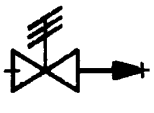
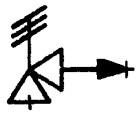
Device Name (Code)	Process Piping Device Symbol CAD/CAM Symbol Name					
Flow Control Valve (FCV)	GLOBE OR PLUG  PIV200 GLOBE PIV260 PLUG  PIV205 GLOBE PIV261 PLUG	GATE  PIV201  PIV206	BALL  PIV202  PIV207	COCK  PIV203  PIV208	BUTTERLY  PIV239	3 & 4 WAY  PIV204  PIV209
Check Valve (CV)	 PIV210	 PIV211		 PIV212	 PIV213	
Relief Valve (RV)	 PIV214	 PIV215				
Quick Opening Valve (QV)	GLOBE OR PLUG  PIV216 GLOBE PIV262 PLUG	GATE  PIV217	BALL  PIV218	COCK  PIV219		

Table 9.2. Continued

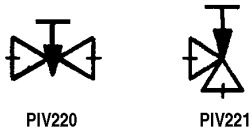
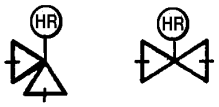
Device Name (Code)	Process Piping Device Symbol CAD/CAM Symbol Name
Needle Valve (NV)	 PIV220 PIV221
Hand Regulator (HR)	HAND  PIV222 PIV223
Hand Loader (HL)	HAND  PIV225
Remote Regulator (RR)	REMOTE  PIV224

Table 9.2. Continued

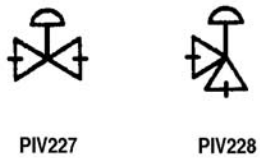
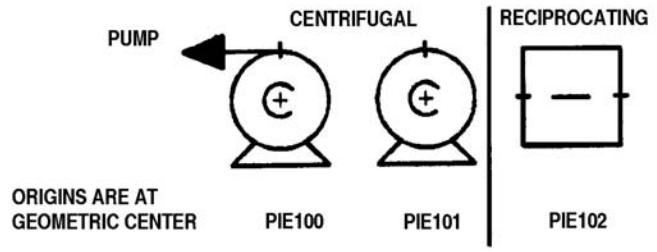
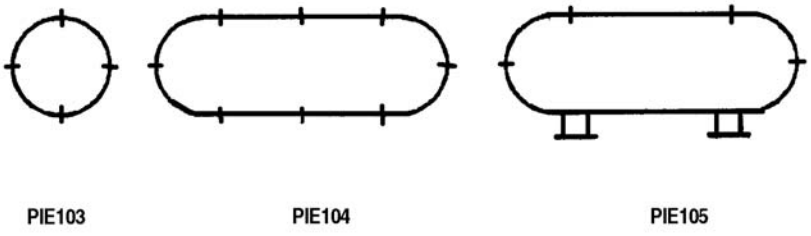
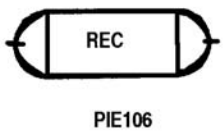
Device Name (Code)	Process Piping Device Symbol CAD/CAM Symbol Name
Remote Loader (RL)	
Pressure Regulating Valve (PRV)	
Pump (P)	
Pressure or Vacuum Vessel (T)	
Receiver (REC)	

Table 9.2. Continued

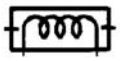
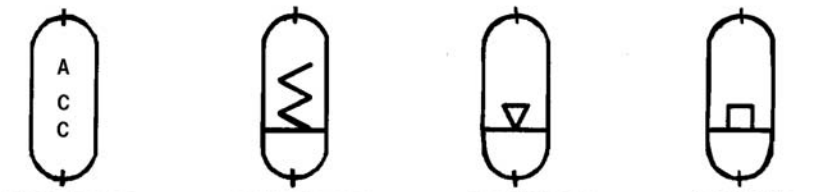
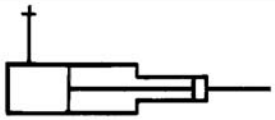
Device Name (Code)	Process Piping Device Symbol CAD/CAM Symbol Name
Trap (TP)	 PIE107
Filters (F)	IN-LINE TEE WYE  PIE108 PIE109 PIE110
Strainer (ST)	 PIE111
Mufflers (S)	 PIE112
Heat Exchanger (HE)	 PIE113
Accumulators (ACC)	 BASIC SYMBOL PIE114 SPRING LOADED PIE115 GAS CHARGED PIE116 WEIGHTED PIE117
Pressure Intensifier (C)	 PIE143

Table 9.2. Continued

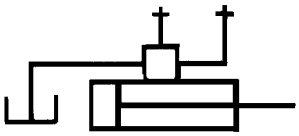
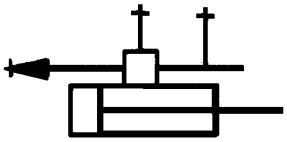
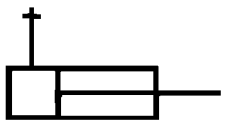
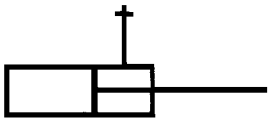
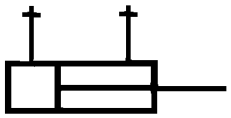
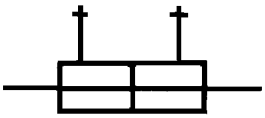
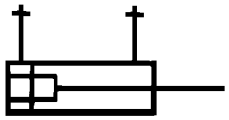
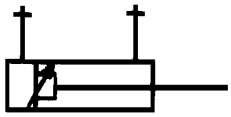
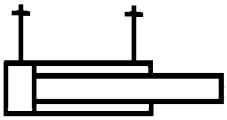
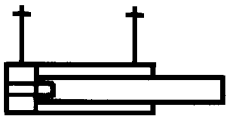
Device Name (Code)	Process Piping Device Symbol / CAD/CAM Symbol Name
Servo Positioner (C)	HYDRAULIC  PIE144 PNEUMATIC  PIE145
Cylinders, Single-Acting-Hydraulic and Pneumatic (C)	 PIE135  PIE136
Cylinders, Double-Acting-Hydraulic and Pneumatic (C)	SINGLE END ROD  PIE138 DOUBLE ND ROD  FIXED CUSHION ADVANCE & RETRACT  PIE139 ADJUSTABLE CUSHION ADVANCE ONLY  PIE140 LARGE DIAMETER ROD NON-CUSHION  PIE141 LARGE DIAMETER ROD CUSHION  PIE142

Table 9.2. Continued

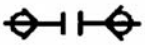
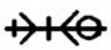
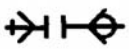
Device Name (Code)	Process Piping Device Symbol / CAD/CAM Symbol Name
Vented Reservoir (RES)	 PIG100
Pressurized Reservoir (RES)	 PIG101
Quick Disconnect (QD)	CONNECTED / DISCONNECTED WITHOUT CHECKS  PIF107  PIF108 WITH TWO CHECKS  PIF109  PIF110 WITH ONE CHECK  PIF111  PIF112
Air Lubricator (LUB)	 PIE170
Flowmeter (FM)	 PII100
Nozzle (N)	 PII101

Table 9.2. Continued

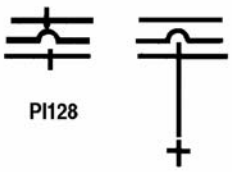
Device Name (Code)	Process Piping Device Symbol CAD/CAM Symbol Name
Venturi (VT)	 PI102
Orifice (OR)	 PI103
Sight Gage (SG)	
Temperature Transducer (TT)	 PI114
Temperature Switch (TS)	 PI115
Flow Switch (FS)	 PI116
Water Detector (WD)	 PI117
Rupture Relief Disc (RD)	 PI128 PI129

Table 9.2. Continued

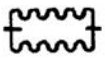
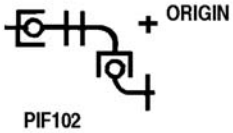
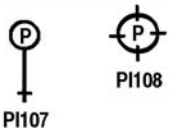
Device Name (Code)	Process Piping Device Symbol / CAD/CAM Symbol Name
Flexible Hose (FH)	 PIF100
Expansion Joint (EJ)	 PIF101
Swivel Joint (SJ)	 PIF102
Spectacle Blind (SB)	 PIF103
Line Blind (LB)	 PIF104
Level Gauge (LG)	 PI105
Level Switch (LS)	 PI106
Pressure Gauge (PG)	 PI107 PI108

Table 9.2. Continued

Device Name (Code)	Process Piping Device Symbol CAD/CAM Symbol Name
Pressure Switch (PS)	 PI109
Temperature Gauge (TG)	 PI100
Pressure Autosyn (PA)	 PI111
Pressure Transducer (PT)	 PI112
Thermocouple (TC)	 PI113

Table 9.2. Continued

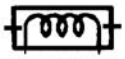
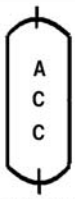
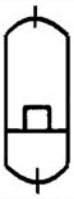
FLUID POWER Device Name (Code)	Fluid Power Piping Device Symbol CAD/CAM Symbol Name			
Mufflers (S)	 PIE112			
Heat Exchanger (HE)	 PIE113			
Accumulators (ACC)	 BASIC SYMBOL PIE114	 SPRING LOADED PIE115	 GAS CHARGED PIE115	 WEIGHTED PIE117
Heaters (HE)	 PIE115	LIQUID MEDIUM  PIE119	GASEOUS MEDIUM  PIE120	
Coolers (HE)	 PIE121	 PIE122	 PIE123	
Temperature Controllers (HE)	 PIE124	LIQUID MEDIUM  PIE125	GAS MEDIUM  PIE126	

Table 9.2. Continued

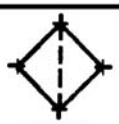
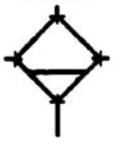
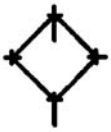
Device Name (Code)	Fluid Power Piping Device Symbol CAD/CAM Symbol Name
Filter-Strainer (F)	 PIE127
Separator (SEP)	WITH MANUAL DRAIN  PIE128 WITH AUTOMATIC DRAIN  PIE129
Filter-Separator (FS)	 PIE130  PIE131
Dessicator (DES)	 PIE132
Lubricator (LUB)	WITH NO DRAIN  PIE133 WITH MANUAL DRAIN  PIE134

Table 9.2. Continued

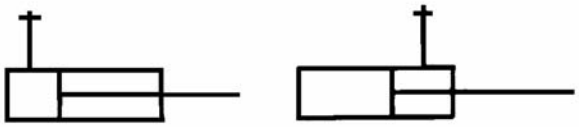
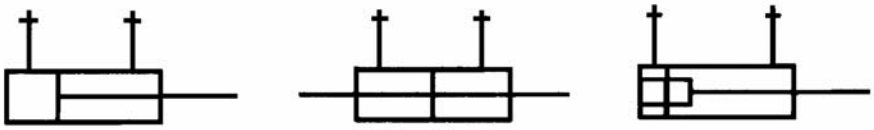
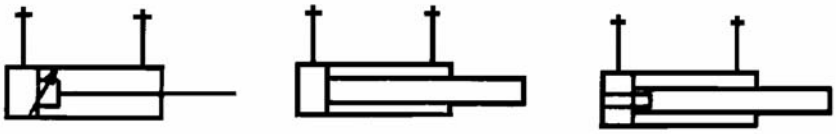
Device Name (Code)	Fluid Power Piping Device Symbol CAD/CAM Symbol Name
Cylinders, Single-Acting-Hydraulic and Pneumatic (C)	 PIE135 PIE136
Cylinders, Double-Acting-Hydraulic and Pneumatic (C)	SINGLE END ROD DOUBLE END ROD FIXED CUSHION ADVANCE & RETRACT  PIE137 PIE138 PIE139 ADJUSTABLE CUSHION ADVANCE ONLY LARGE DIAMETER ROD NON-CUSHION LARGE DIAMETER ROD CUSHION  PIE140 PIE141 PIE142
Pressure Intensifier (C)	 PIE143

Table 9.2. Continued

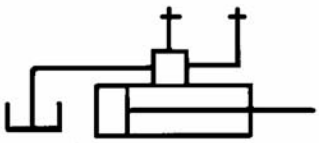
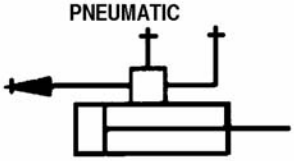
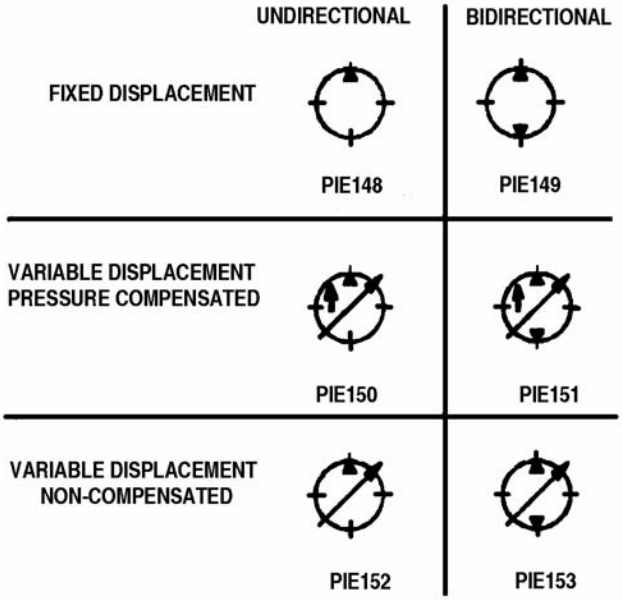
Device Name (Code)	Fluid Power Piping Device Symbol CAD/CAM Symbol Name
Servo Positioner (C)	HYDRAULIC  PIE144 PNEUMATIC  PIE145
Hydraulic Pump (P)	

Table 9.2. Continued

Device Name (Code)	Fluid Power Piping Device Symbol CAD/CAM Symbol Name
Hydraulic Motor (M)	UNDIRECTIONAL / BIDIRECTIONAL FIXED DISPLACEMENT   PIE154 PIE155 VARIABLE DISPLACEMENT    PIE156 PIE157 PIE158
Pump-Motor Hydraulic (P)	ONE DIRECTION AS PUMP OTHER DIRECTION AS MOTOR  PIE159 ONE DIRECTIONS AS EITHER PUMP OR MOTOR  PIE160 BOTH DIRECTIONS AS EITHER PUMP OR MOTOR VARIABLE DISPLACEMENT PRESSURE COMPENSATED  PIE161
Pump, Pneumatic (P)	COMPRESSOR  PIE162 VACUUM PUMP  PIE163
Motor, Pneumatic (M)	UNDIRECTIONAL  PIE164 BIDIRECTIONAL  PIE165

Table 9.2. Continued

Device Name (Code)	Fluid Power Piping Device Symbol CAD/CAM Symbol Name
Oscillator (OS)	HYDRAULIC  PIE166 PNEUMATIC  PIE167
Motors/Engines (M)	ELECTRIC MOTOR  PIE168 HEAT ENGINE  PIE169
Pressure (PG)	 PI115
Temperature (TG)	 PI119
Flow Rate (FM)	 PI120
Totalizing Flow (FM)	 PI121
Venturi (VT)	 PI122

Table 9.2. Continued

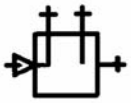
Device Name (Code)	Fluid Power Piping Device Symbol CAD/CAM Symbol Name
Orifice (OR)	 PI123
Pitot Tube (PIT)	 PI124
Nozzles (N)	 PI126 PI125
Pressure Switch (PS)	 PI127
Flexible Line (FH)	 PIF105
Line With Fixed Restriction (OR)	 PIF106

Table 9.2. Continued

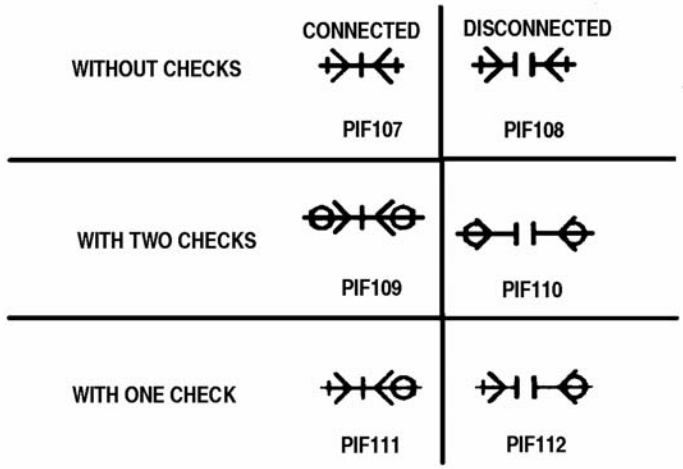
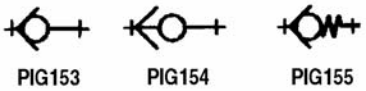
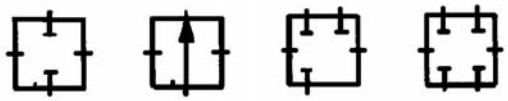
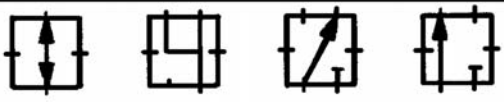
Device Name (Code)	Fluid Power Piping Device Symbol CAD/CAM Symbol Name
Quick Disconnects (QD)	
Vented Reservoir (RES)	
Pressurized Reservoir (RES)	
Check Valve (CV)	

Table 9.2. Concluded

Device Name (Code)	Fluid Power Piping Device Symbol CAD/CAM Symbol Name
Valve (V)	 PIG123 PIG124 PIG125 PIG126  PIG127 PIG128 PIG129 PIG130  PIG131 PIG132 PIG133 PIG134  PN264

SYMBOL ORIGINS FOR CAD
UNLESS OTHERWISE NOTED

1. ORIGINS FOR IN-LINE SYMBOLS ARE LOCATED COLINEAR WITH AND MIDWAY BETWEEN THE MAJOR CONNECT NODES
2. ANGLE VALVE SYMBOL ORIGINS ARE LOCATED AT THE VERTEX OF THE ANGLE
3. SYMBOLS WITH EXTENSION LINES HAVE THEIR ORIGINS LOCATED AT THE END OF THE EXTENSION
4. SYMBOLS WITH ONE CONNECT NODE HAVE THEIR ORIGINS THAT NODE

Table 9.3 Kinds of Service

Air	Atmospheric	ATM
	Instrument	IA
	Low Pressure (0-150 psig)	LPA
	High Pressure (>150-5000 psig)	HPA
	Service (0-150 psig)	SA
	Super Pressure (>5000 psig)	SPA
	Vacuum	VC
Fuels	Anhydrous Ammonia	AA
	Aviation Gasoline	AG
	Alcohol-Methyl	MA
	Alcohol-Potassium Tertiary	PTA
	Aerozine-SO	AZ
	Jet Engine (JP-4, 5, etc.)	JP
	Monomethyl Hydrazene	MMH
	Methane	MTH
	Natural Gas	NG
	Oil	FO
	Propane	PP
	Ramjet	RJP
	Rocket (RP1, etc.)	RP
	UDMH	UH
Gases, Normal Air		See Air
	Argon AR	
	Carbon Dioxide	CO2
	Carbon Monoxide	CO
	Deuterium	GD
	Ethylene	GE
	Fluoride	FL
	Halon	HA
	Helium	GHe
	Hydrogen	GH
	Nitrogen	GN
	Nitrogen LOX Compatible	GNL
	Nitrogen Fuel Compatible	GNF
	Sodium Hexafluoride	NAF
	Oxygen	GO
Gases, liquefied	Nitrogen	LN
	Oxygen	LO

Table 9.3. Concluded

Oils	Fuel	See Fuels
	Hydraulic	HO
	Lubricating	OL
Oxidizers	Chlorine Trifluoride	CTF
	IRENA	NA
	Nitrogen Tetroxide	NT
	Oxygen	See Gases
	Oxygen Difluoride	OF
	Potassium Carbonate	PC
	Potassium Hydroxide	PH
	Strontium Perchlorate	SPC
Pyrophorics	Boron Hydride	BH
	Sodium Potassium	NAK
	Triethylaluminum	TEA
	Triethylboron	TEB
Refrigerants and/or Cleaning Fluids	Ethylene Glyco	GL
	Freon	FR
	Methyl Chloride	MC
	Mineral Spirits	MS
	Trichlorethylene	TE
Steam	Condensate	STC
	Supply	ST
Water	Cooling or Chilled	CW
	Demineralized	DW
	Distilled	W
	Fire Protection	FW
	Potable	PW
	Raw	RW
	Treated Water	TW
Sewage	Raw or Treated	SW

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10.0 WELDING DESIGN AND DRAFTING STANDARDS

10.1 PURPOSE

The purpose of this standard is to establish design and drafting standards for specifying welds and weld inspection requirements on drawings prepared for AEDC utilization.

10.2 SCOPE

The requirements given herein shall be used in all designs and on all drawings requiring welding.

10.3 REQUIREMENTS

10.3.1 **Statement of Design and Construction—**Drawings requiring welding shall specify code requirements conforming to one or more of the following:

a. ASME B&PVC, Section VIII, Division 1 or Division 2, and Section IX.

b. ANSI/ASME B31, Piping Codes and ASME B&PVC, Section IX.

c. AWS Structural Welding Codes, D1.1 — Steel, or D1.2 — Aluminum

d. NBBI National Board Inspection Code, NB-23 (Repairs and Alterations to pressure systems only)

e. API 650 Welded Steel Tanks for Oil Storage

f. AWWA D100 Standard for Welded Steel Tanks for Water Storage.

g. Specialized welding procedure developed by Materials Testing and Inspection (AEDC Welding Engineer) for a particular weldment.

10.3.2 **Typical Drawing Notes--See Section 7.**

10.3.3 **Construction Materials**--Construction in accordance with 10.3.1A or repair/alteration in accordance with 10.3.1 D requires that ASME code-approved materials be used. Materials with the ASTM designation may be used if the ASME material is not available. If the ASTM materials are used, the pertinent additional requirements of the ASME specification must be verified and documented. The additional verification can be performed by Materials Testing and Inspection (AEDC Welding Engineer) Materials procured to an ASTM specification shall be used for construction in accordance with 10.3.1B and C Materials not identified with an ASTM- or ASME-approved specification may be used in non-code applications or where requirements dictate use of material on hand. Welding of such material shall be performed by qualified welders using qualified welding procedures approved in the same manner as for code approved materials. For applications where a qualified weld procedure does not exist and development of the weld procedure would be impractical, Materials Testing and Inspection (AEDC Welding Engineer) shall specify the welding process.

10.3.4 **Testing and Nondestructive Examination Requirements**

10.3.4.1 The ASME B&PVC and ANSI B31 standards in paragraph 10.3.1 specify the minimum testing and nondestructive examination requirements for compliance. The designer must specify either the extent of examination required or include information necessary to determine the extent, such as joint efficiency (ASME VIII) or fluid service category (ASME B31.3). Requirements beyond the code minimum shall be stated on the drawing. Acceptance criteria, if different from the referenced code, must be specified.

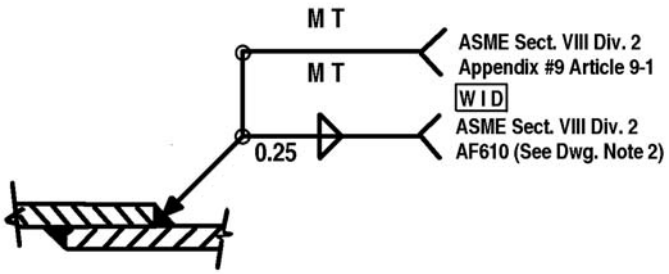
10.3.4.2 The design conditions (design pressure and temperature range) must be specified for all pressure systems as defined in AEDC Engineering Standards T-1 and T-2.

10.3.4.3 Test pressure shall be specified if pneumatic or hydrostatic testing is required.

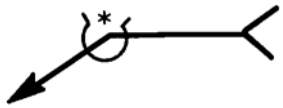
10.3.5 **Welding and Non-Destructive Testing Symbols**

10.3.5.1 Welding symbols shall be given for each weld shown on the drawing. Welding symbols shall conform to American Welding Society A2.4, Symbols for Welding and Non-Destructive Testing.

10.3.5.2 Example callout:



10.3.5.3 Interrupted welds for vents for vacuum service are indicated by a variation of the “weld all around symbol” as follows:



* Length of Weld Interruption

10.3.6 See AEDC-ENGR-STD-T5 for additional information on welding and inpsection requirements, including qualified welding procedure specifications.

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STANDARD WELDING SYMBOLS

Basic Welding Symbols and Their Location Significance

Location Significance	Fillet	Plug or Slot	Spot or Projection	Seam	Back or Backing	Surfacing	Scarf for Brazed Joint	Flange Edge
Arrow Side					Groove weld symbol			
Other Side					Groove weld symbol	Not used		
Both Sides		Not used	Not used	Not used	Not used	Not used		Not used
No Arrow Side or Other Side Significance	Not used	Not used			Not used	Not used	Not used	Not used

Supplementary Symbols Used with Welding Symbols

Convex Contour Symbol

Convex contour symbol indicates face of weld to be finished to convex contour

Finish symbol (user's standard) indicates method of obtaining specified contour but not degree of finish

Weld-All-Around Symbol

Weld-all-around symbol indicates that weld extends completely around the joint

Joint with Backing

With groove weld symbol

See note

Note: Material and dimensions of backing as specified

Joint with Spacer

With modified groove weld symbol

See note

Double-bevel-groove

Note: Material and dimensions of spacer as specified

Melt-Thru Symbol

Any applicable weld symbol

1 mm

Melt-thru symbol is not dimensioned (except height)

Flush Contour Symbol

Flush contour symbol indicates face of weld to be made flush. When used without a finish symbol, indicates weld without subsequent finishing

Finish symbol (user's standard) indicates method of obtaining specified contour but not degree of finish

Multiple Reference Lines

First operation shown on reference line nearest arrow — 1st

Second operation, or supplementary data — 2nd

Third operation, or test information — 3rd

Field Weld Symbol

Field Weld symbol indicates that weld is to be made at a place other than that of initial construction

Complete Penetration

Indicates complete penetration regardless of type of weld or joint preparation

CP

Location of Elements of a Welding Symbol

Finish symbol

Contour symbol

Root opening; depth of filling for plug and slot welds

Effective throat

Depth of preparation; size or strength for certain welds

Specification, process, or other reference

Tail (Tail omitted when reference is not used)

Basic weld symbol or detail reference

Groove angle; included angle of countersink for plug welds

Length of weld

Pitch (center-to-center spacing) of welds

Field weld symbol

Arrow connecting reference line to arrow side member of joint

Weld-all-around symbol

Reference line

Elements in this area remain as shown when tail and arrow are reversed

(N) Number of spot or projection welds

F A R S (E) L P

(BOTH SIDES) (ARROW SIDE) (OTHER SIDE)

Supplementary Symbols

Weld-All-Around	Field Weld	Melt-Thru	Backing, Spacer	Contour		
				Flush	Convex	Concave

Basic Joints-Identification of Arrow Side and Other Side of Joint

Butt Joint

Arrow of welding symbol

Arrow side of joint

Other side of joint

Corner Joint

Arrow side of joint

Arrow of welding symbol

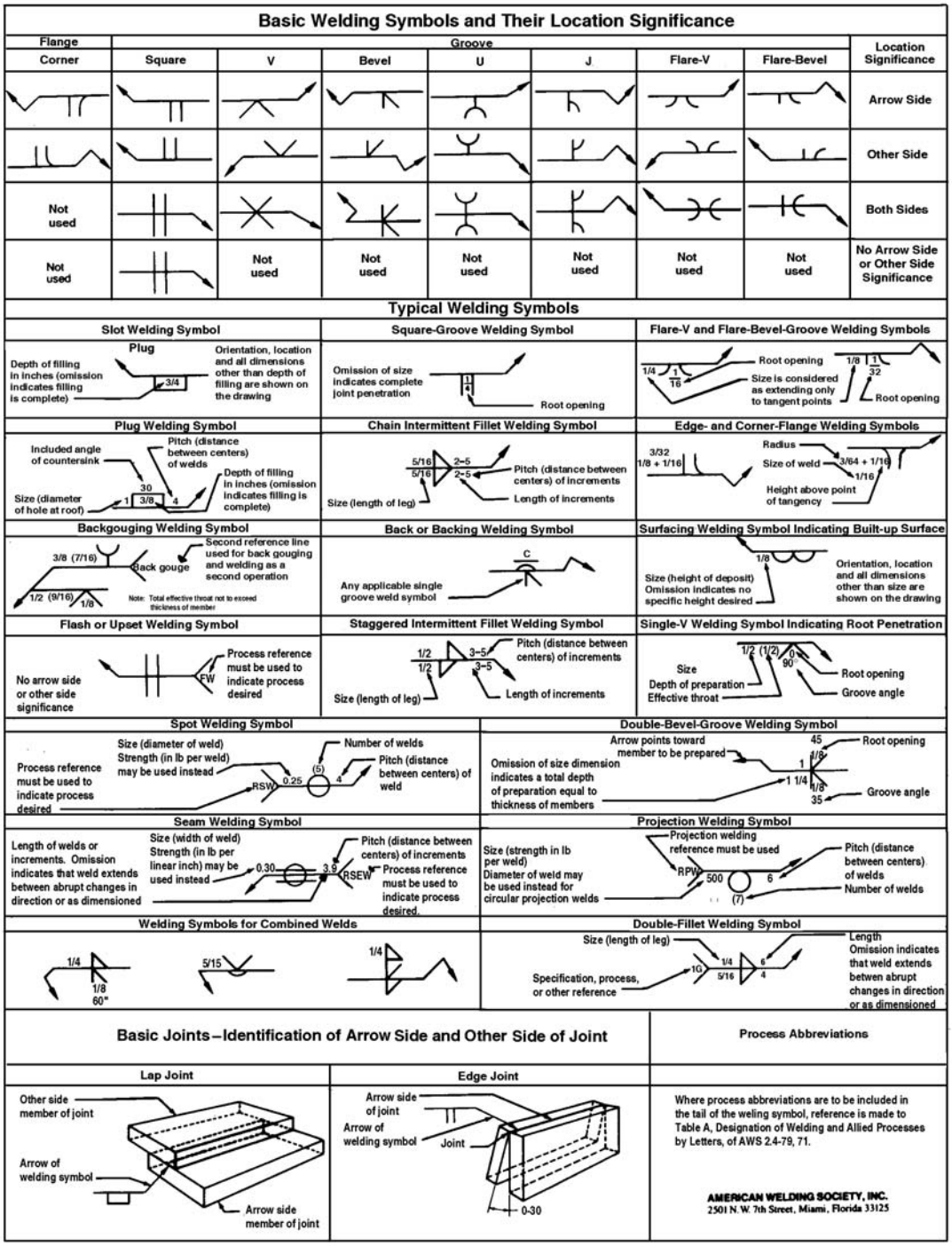
Other side of joint

T-Joint

Arrow of welding symbol

Arrow side of joint

Other side of joint


Basic Welding Symbols and Their Location Significance
Flange
Corner
Groove
Square
V
Bevel
U
J
Flare-V
Flare-Bevel
Location Significance
Arrow Side
Other Side
Not used
Both Sides
No Arrow Side or Other Side Significance
Typical Welding Symbols
Slot Welding Symbol
Plug
Depth of filling in inches (omission indicates filling is complete)
Orientation, location and all dimensions other than depth of filling are shown on the drawing
Square-Groove Welding Symbol
Omission of size indicates complete joint penetration
Root opening
Flare-V and Flare-Bevel-Groove Welding Symbols
Root opening
Size is considered as extending only to tangent points
Plug Welding Symbol
Included angle of countersink
Pitch (distance between centers) of welds
Depth of filling in inches (omission indicates filling is complete)
Size (diameter of hole at roof)
Chain Intermittent Fillet Welding Symbol
Pitch (distance between centers) of increments
Length of increments
Size (length of leg)
Edge- and Corner-Flange Welding Symbols
Radius
Size of weld
Height above point of tangency
Backgouging Welding Symbol
Second reference line used for back gouging and welding as a second operation
Back gouge
Note: Total effective throat not to exceed thickness of member
Back or Backing Welding Symbol
Any applicable single groove weld symbol
Surfacing Welding Symbol Indicating Built-up Surface
Size (height of deposit) Omission indicates no specific height desired
Orientation, location and all dimensions other than size are shown on the drawing
Flash or Upset Welding Symbol
No arrow side or other side significance
Process reference must be used to indicate process desired
Staggered Intermittent Fillet Welding Symbol
Pitch (distance between centers) of increments
Length of increments
Size (length of leg)
Single-V Welding Symbol Indicating Root Penetration
Size
Depth of preparation
Effective throat
Root opening
Groove angle
Spot Welding Symbol
Size (diameter of weld)
Strength (in lb per weld) may be used instead
Number of welds
Pitch (distance between centers) of weld
Process reference must be used to indicate process desired
Double-Bevel-Groove Welding Symbol
Arrow points toward member to be prepared
Omission of size dimension indicates a total depth of preparation equal to thickness of members
Root opening
Groove angle
Seam Welding Symbol
Length of welds or increments. Omission indicates that weld extends between abrupt changes in direction or as dimensioned
Size (width of weld)
Strength (in lb per linear inch) may be used instead
Pitch (distance between centers) of increments
Process reference must be used to indicate process desired.
Projection Welding Symbol
Projection welding reference must be used
Size (strength in lb per weld)
Diameter of weld may be used instead for circular projection welds
Pitch (distance between centers) of welds
Number of welds
Welding Symbols for Combined Welds
Double-Fillet Welding Symbol
Size (length of leg)
Specification, process, or other reference
Length
Omission indicates that weld extends between abrupt changes in direction or as dimensioned
Basic Joints–Identification of Arrow Side and Other Side of Joint
Lap Joint
Other side member of joint
Arrow of welding symbol
Arrow side member of joint
Edge Joint
Arrow side of joint
Arrow of welding symbol
Joint
0-30
Process Abbreviations
Where process abbreviations are to be included in the tail of the weling symbol, reference is made to Table A, Designation of Welding and Allied Processes by Letters, of AWS 2.4-79, 71.
AMERICAN WELDING SOCIETY, INC.
2501 N.W. 7th Street, Miami, Florida 33125

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11.0 ELECTRICAL/ELECTRONIC DESIGN AND DRAFTING STANDARDS

11.1 PURPOSE

This standard establishes engineering drafting requirements for electrical and electronic drawing for all new systems and revisions to existing systems to be constructed at AEDC.

11.2 SCOPE

This standard contains engineering drafting standards including graphic symbols, class designation letters, and CAD/CAM symbol names for producing electrical and electronic drawings. It also includes equipment/part/device identification and indicator/signal light color code requirements to aid in operation and maintenance activities conducted at AEDC.

11.3 TYPES OF DRAWINGS

11.3.1 **Diagramatic drawings** — Diagramatic drawings consist of drawings conveying basic information about the operation of a circuit or a system of circuits, but omits physical and detailed information unrelated to operation. These type drawings are not drawn to scale and are usually on separate sheets. Typical drawings are described below.

11.3.1.1 **Single-Line or One-Line Diagram —** A single-line or one-line diagram shows, by means of single lines and graphic symbols, the course of an electric circuit or circuits and the component devices or parts used therein. Physical relationships may be disregarded.

11.3.1.2 **Schematic or Elementary Diagram** — A schematic or elementary diagram shows, by means of connecting lines and graphic symbols, the electrical connections and functions of a specific circuit arrangement. The diagram facilitates tracing the circuit and its functions without regard to the actual physical size, shape, or location of the component device or parts. On complex control circuits where the function is not obvious on the diagram, a detailed written “sequence of operation” shall be provided on the same sheet as the diagram.

11.3.1.3 **Logic Diagram** — A logic diagram illustrates with standard logic symbols, the details of signal flow and control. Its prime function is to indicate all logic relationships so a user can readily understand the function of the logic without specific knowledge of the device represented.

11.3.1.4 **Wiring or Connection Diagram —** A wiring or connection diagram shows the connections of an installation or its component devices or parts. It may cover internal or external connections, or both, and contain details required to make or trace the connections. The diagram shall show general physical arrangement of the component devices or parts.

11.3.1.5 **Interconnection Diagram** — An interconnection diagram shows the method of installation and connections between unit assemblies or equipment. The internal connections of unit assemblies and equipment will be omitted.

11.3.1.6 **Riser Diagram** — A riser diagram shows physical relationships, such as for electrical service, feeder and major power runs, unit substations, transformers, switchboards, and panelboards. Conduit and wire sizes serving each piece of electrical equipment shall be indicated.

11.3.1.7 **Block Diagram** — A block diagram shows a system concept in terms of functional blocks, block input sources, and block output sources.

11.3.1.8 **Process and Instrumentation (P & I) Diagram —** A process flow diagram shows all process instrumentation and control components with their functional relationships. P & I diagrams shall be drawn using the symbols shown in ISA Standard ISA-5.1.

11.3.2 **Electrical Layout Drawings** — Electrical layout drawings consist of drawings used in architecture and building construction. Each must be drawn on sheets separate from the other (architectural, civil, structural, mechanical, etc.) drawings and drawn to an appropriate scale. Typical drawings are described below.

11.3.2.1 **Power Plan** — A power plan is a physical plan showing the location of electrical loads and how they are fed from their source of power. Electrical equipment, loads, conduit, and cable sizes are indicated on the plan.

11.3.2.2 **Lighting Plan** — A lighting plan is a physical plan showing the location of lighting fixtures and outlets and how they are fed from their source of power. Conduit and wire sizes are indicated. Lighting fixtures are either identified by a symbol on the lighting plan or in a separate symbol list. Lighting panelboard schedules shall be shown. As a minimum, the lighting panelboard schedule will show the panelboard rating, number and rating of branch circuits, and load or loads served by each branch circuit.

11.3.2.3 **Equipment Location Drawing** — An equipment location drawing shows the location of equipment and/or devices relative to building walls or other fixed objects.

11.3.2.4 **Conduit Layout Drawing** — A conduit layout drawing consists of a general area and/or building plan drawing showing the physical routing of conduit for electrical wiring. The drawing shall show the method for terminating the conduit to equipment.

11.3.2.5 **Grounding Plan Drawing** — A grounding plan drawing shows electrical power and instrumentation grounding methods. The drawing shall show the physical routing or the grounding conductors, and the methods for grounding and bonding the grounding conductor to earth, equipment, and devices.

11.3.3 **Miscellaneous Drawings**

11.3.3.1 **Cable Schedule or Wiring List (Net List)** — A cable schedule or wiring list shows in chart or table form, the identity of conductors and associated items of a cable asembly and point-to-point wiring. Conductor characteristics, such as wire size, number of strands, designations, color code, and attached parts, shall be identified. Certain installation features, such as wire length, termination points, connectors, may be included.

11.3.3.2 **Silkscreen Drawing** — A silkscreen drawing is an undimensioned drawing from which silkscreens, stamps, or other marking mediums are fabricated for marking panels, chassis, printed circuit boards, and the like, prior to assembly of the components.

11.3.3.3 **Assembly Drawing** — An assembly drawing shows the assembled relationship of (a) two or more parts, (b) a combination of parts or subasemblies, or (c) a group of assemblies required to form an assembly of higher order. The drawing shall contain sufficient views to show the relationship between each subassembly and part comprising the assembly.

11.3.3.4 **Printed Circuit Board Drawing** — A printed circuit board drawing shows actual physical arrangement (artwork) of all parts, components, and interconnections that go into making a complete, assembled printed circuit board.

11.4 GENERAL REQUIREMENTS

All drawings shall be prepared as specified in the Standards listed in Section 2 unless otherwise noted in this section.

11.4.1 **Drawing Titles** — The name of the type of drawing shall be included in the title and shall comply with Section 3.4.

11.4.2 **Combined Forms of Drawings** — Combined forms of drawings may be used when the net result is helpful to the user. When this principle is applied, the drawing title must be selected on the basis of the major purpose of the drawing.

11.4.3 **Drawing Size and Format** — All drawing sheets shall be of sized per Section 3 as shown and formatted in Section 3.0. When the interrelated drawings are sectionalized and prepared on different drawings, or as multisheet drawings, suitable cross references shall be provided.

11.4.3.1 **Computer Generated Drawings** — Computer-aided design (CAD) system drawings shall be generate d as addressed in 3.1.

11.4.4 **Line Conventions and Lettering** — The selection of line thickness and letter size shall take into account size reduction to maintain legibility in half-size reduction and microfilmed drawings. Minimum letter size shall be 1/8 in.

11.4.5 **Layout of Drawings** — The layout of drawings that utilize symbols (schematics, one-line, etc.) shall be such that the main features are prominently shown. The parts of the drawing shall be spaced to provide an even balance between blank spaces and lines. Sufficient blank area shall be provided for notes or reference information when required around symbols. If possible, large spaces should be avoided except for space provisions for future growth.

11.4.5.1 **Grouping of Parts** — Grouping of parts shall be indicated by phantom lines when necessary for clarity. Typical groupings are unit assemblies, subassemblies, printed circuits, contactor parts, and relays. A dashed line used to indicate shielding also implies that the parts enclosed by the dashed line are grouped.

11.4.6 **Drawing Legend** — A drawing legend explaining the meaning of graphic symbols, supplemenatary data, abbreviations, etc., shall be provided on drawings.

11.4.7 **Drawing Notes** — Drawing notes shall be provided to facilitate understanding of the drawing and to specify procedures, codes, and standards to be followed. Typical drawing notes are contained in Section 21.

11.4.8 **Human-Factors Engineering** — Human-factors engineering shall be considered in all designs. Particular attention shall be paid to control panel layout and labeling of control devices and displays on the panel. Consult the following for guidance:

AFSC DH1-3Human Factors Engineering

MIL-STD-1472CEngineering Design Criteria for Military Systems, Equipment and Facilities.

A typical panel layout illustrating the application of human-factors engineering is shown in Appendix A of this section.

11.4.9 **Other Applicable Requirements** — Applicable sections of Standard T-3 not mentioned in this Section shall be followed in preparing, numbering, certifying, revising, retention, and destruction of drawings.

11.5 GRAPHIC SYMBOLS, CLASS DESIGNATION LETTERS AND ABBREVIATIONS

11.5.1 **Graphic Symbols** — Graphic symbols used on drawings to represent a part or device in a circuit shall conform with ANSI or ISA Standards or other national-level standards if the symbol is not covered in the ANSI or ISA Standards. If a suitable standard does not exist, any special symbol used shall be explained in a legend or note on the drawing. Graphic symbols may be drawn to any proportional size that suits the drawing, provided the selection takes into account half size reduction and microfilming drawings. A list of commonly used graphic symbols are contained in the Appendixes of this section.

11.5.1.1 **Terminal Identification** — The symbol for a terminal (o) may be shown at the point of attachment of conductors on graphic symbols, but such terminal symbols should not be considered to be a part of the symbol. The use of terminal symbols on drawings are optional, except do not show terminals on schematic or elementary diagrams unless those terminals are accessible to the user.

11.5.1.2 **Similar or Identical Graphic Symbols** — When graphic symbols having similar or identical shapes, but different meanings, are used on the same drawing or set of drawings, steps (caution notes, comparison charts, etc.) shall be taken to illustrate the conflict.

11.5.1.3 **Representation of Electrical Contacts** — Switch symbols shall be shown on drawings in the position of no applied operating force. For switches that may be in any one of two or more positions with no operating force or switches actuated by some mechanical or electrical means, a drawing note shall identify the state of the switch. Relay contacts shall be shown in the de-energized or nonoperated state.

11.5.1.4 **Addition of Supplementary Data** — Details of type, impedance, rating, and the like may be added adjacent to graphic symbols.

11.5.2 **Class Designation Letters** — Class designation letters used on drawings to identify a part or device shall conform with ANSI or ISA Standards or other national-level standards if the designation letter is not covered in the ANSI or ISA Standards. If no suitable standard exists, any special designation letter used shall be explained in a legend or note on the drawing. Class designation letters are shown in correlation with graphic symbols in Appendixes C, D, and E of this section.

11.5.3 **Graphic Symbols and Class Designation Letters Used on Existing Drawings** — When revising an existing drawing, use the graphic symbols and class designation letters outlined in this section. Graphic symbol and class designation letters that appear on existing drawings that are not in compliance with this standard do not have to be revised. However, notes or legends shall be added to avoid misinterpretation.

11.5.4 **Abbreviations** — Abbreviations used on drawings shall conform to ANSI Standard Y14.38 or other national-level standards if the abbreviation is not covered in the ANSI Standard. If no

abbreviation exists, a special abbreviation may be used but must be explained in a legend or note on the drawing.

11.6 PART AND DEVICE IDENTIFICATION ON DRAWINGS

Graphic symbols representing parts and devices on drawings shall be identified by class designation letter and other supplementary data necessary to facilitate installation, future design, troubleshooting, and operation and maintenance activities. Typical notations are shown in Appendix B.

11.7 FIELD IDENTIFICATION OF EQUIPMENT, PARTS, AND DEVICES

Drawings shall provide instructions and details for identifying equipment, parts, and devices. Identifying information should facilitate troubleshooting and other operation and maintenance activities. Identification media include nameplate, directories, tags, and labels, all of which shall be constructed from noncorrodible material and permanently affixed to the equipment, part, or device. Descriptions and/or typical examples of identification methods are presented in the following paragraphs. Principles presented shall apply to identifying all equipment, parts, and devices.

11.7.1 **Circuit Interrupting Equipment** — A nameplate shall be provided on the exterior door of circuit interrupting equipment, such as panelboards, breakers, safety switches, and starters. The nameplates shall include information such as identifying number, voltage rating, current rating, frame size, load served, power source, and reference drawing.

EXAMPLE (CIRCUIT BREAKER ENCLOSURE NAMEPLATE):

ACB 1
3 PH, 480 V, 60 HZ
400 AT/600 AF
AHU No. 3
FED FROM MCC2, B-2
DWG. NO. RNTc6821.50

--ID NUMBER
--VOLTAGE RATING
--CURRENT RATING/FRAME SIZE
--LOAD SERVED
--POWER SOURCE
--REFERENCE DRAWING

11.7.2 **Power and Lighting Panelboard Directories** — Power and lighting panelboard directories shall be typed or handwritten (if legible), or the panelboard schedule shown on the drawing may be cut out and placed in a transparent cover and secured to the inside panelboard door. The directory shall indicate the equipment served by each circuit including the location of the equipment. Each time a load is removed, revised, or added to a panelboard, the directory and the affected drawing shall be revised to reflect change.

EXAMPLE:

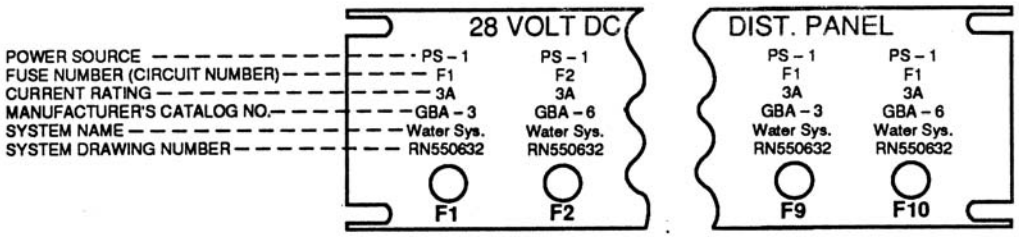
PPL Panelboard Schedule Ref. Drawing_____							
123 amp, 3 wire, 120/208 volts (main lugs only)							
Serves Equipment	No Poles	Breaker Number	Breaker Number	Breaker Rating	Breaker Raging	No. Poles	Serves Equipment
Exit Lights Room 102	1	20	1	2	20	1	Office 105 Receipts
Office 110 Receipts	1	20	3				AC Unit
Sump Pump No. 2	1	20	5	4	100	3	Conf. Rm. No. 2
Roof AHU No. 10	1	20	7				
Lights Restroom 2	1	20	9	10	20	1	Water Cooler Hall

11.7.3 **Fused Circuits in Junction Box** — A fuse legend shall be typed or cut from the drawing showing the legend and placed in a transparent cover and secured inside the junction box door. The legend shall indicate each fuse's identification number, power source, current rating, interrupting rating, manufactuer' designation or catalog number, system served, and reference drawing. Each time a load is removed, revised, or added to a panelboard, the legend and the affected drawing shall be revised to reflect the change.

Fuse Legend						
Fuse No. (CircuitNumber)	Power Source	Current Rating	Interrupting Rating*	Symbol (optional)	System Name	System Drawing No.
F1	PS-1	3A	N/A	GBA-3	Water	RN550632
F2		6A		GBA-6	System	
F3		3A		GBA-3		
F4		6A		GBA-6		
F5		3A		GBA-3		
F6		6A		GBA-6		
F7		3A		GBA-3	Water	
F8	PS-1	6A	N/A	GBA-6	System	RN550632

* Use N/A (not applicable) if fuse does not have an interrupting rating.

11.7.4 **Fuse and Breaker Control Panels** — Fuses and circuit breakers shall be identified by power source, fuse number, current rating, interrupting rating, manufacturer's designation or catalog number (if fuse), system served, and reference drawing. Each time a load is removed, revised, or added, the fuse or breaker designation and the affected drawing shall be revised.



11.7.5 **Cable and Conductor Identification** — Each cable and conductor shall be identified by a number, letter, or number-letter combination. Consecutive numbering is preferred. The identification shall be used only once. Each cable and conductor shall have the same identification at all terminals and tie points. All cables and conductors connected to the same terminal or tie point shall have the same identification. Where multiconductor cable is used, a color code may be used to supplement identification. Where color-coded multiconductor cable is used for wiring identical components, such as limit switches, the color code shall be consistent.

11.7.6 **Conduit and Cable Tray Identification** — Conduit and cable tray shall be identified by number, letter, or number-letter combination. Consecutive numbering is preferred. The identifier shall be used only once. Each conduit and cable tray shall have the same identification at both terminal points. Conduits shall be marked with orange color bands in accordance with AEDC Safety Standard D-3, Identification of Piping Systems.

11.8 INDICATOR/SIGNAL LIGHT COLOR CODE

Indicating and signal light color code used at AEDC is shown below. The light colors shall be used for the conditions indicated for all new systems and for old systems when they are modified or expanded.

COLOR	CONDITION
White	Equipment operating; control circuit on; valve fully open, functioning condition; air pressure normal.
Blue	*Equipment not operating; shut off; standing by; circuit not in use; valve closed. Not used in primary electrical power switchgear.
Green	Ready to run; go ahead; for preliminary steps of sequence operation before white light operating condition. Open circuit, to be used at primary electrical power switchgear only.
Blue and White	Indicates a position between open and closed. Numbers may be used on white lights to indicate different circuits or different positions.
Amber or Yellow	Caution; warning; condition requiring attention at later time; temporary condition; intermediate valve position. Numbers may be used on lights to indicate different circuits or different position.
Red	*Immediate action; danger; emergency; fire; combustible vapor, dangerous overheating. Closed circuit, to be used at primary electrical power switchgear only.
Flashing	Flashing of any color indicates that the present position or condition is the result of an automatic protective relay operation or a faulty sequence operation.

* For systems operating at 480 volts and above, the term “primary electrical power switchgear” includes (a) high voltage switchgear, (b) unit substations, (c) power control center, (d) distribution panels and (e) motor starters.

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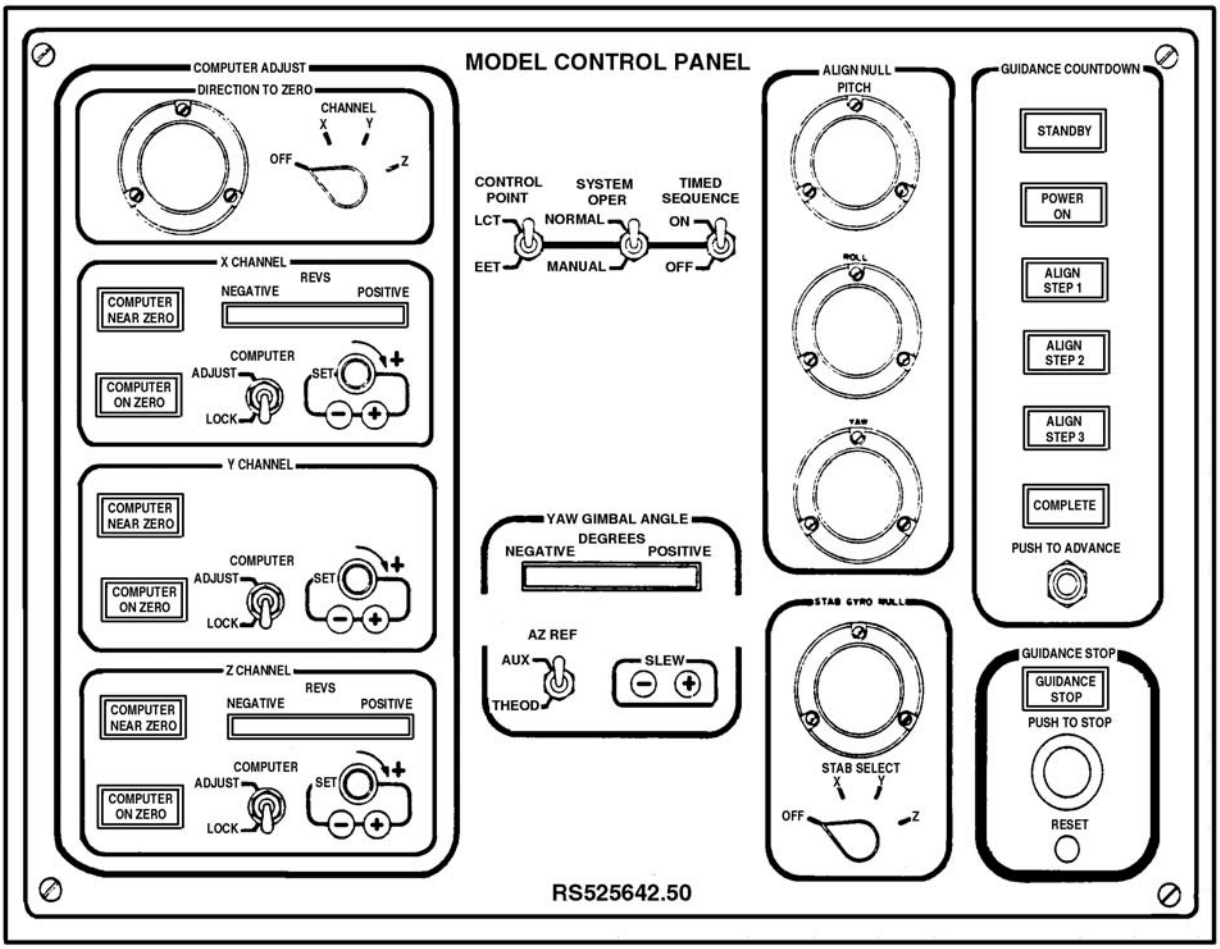
APPENDIX A
PANEL LAYOUT ILLUSTRATING APPLICATION OF HUMAN FACTORS ENGINEERING



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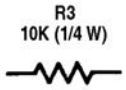
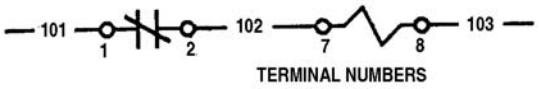
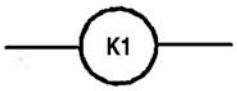
APPENDIX B
TYPICAL NOTATIONS FOR PART AND DEVICE IDENTIFICATION



RESISTOR

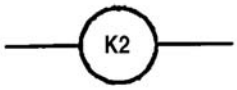


TERMINAL AND WIRE DESIGNATIONS



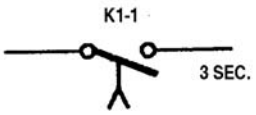
T.D.P.U.
0.3 SEC

TIME DELAY RELAY COIL



T.D.D.O.
0.3 SEC

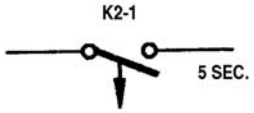
TIME DELAY RELAY COIL



T.D.P.U.

(TIME DELAY TO PICK-UP)
(WHEN COIL ENERGIZED)
(N.O. CONTACT)
(TIMES OUT IN 3 SEC.)

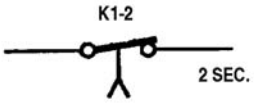
TIME DELAY RELAY CONTACTS



T.D.D.O.

(TIME DELAY TO DROP-OUT)
(WHEN COIL DE-ENERGIZED)
(N.O. CONTACT)
(TIMES OUT IN 5 SEC.)

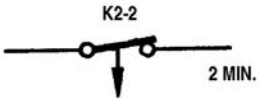
TIME DELAY RELAY CONTACTS



T.D.P.U.

(TIME DELAY TO PICK-UP)
(WHEN COIL ENERGIZED)
(N.C. CONTACT)
(TIMES OUT IN 2 SEC.)

TIME DELAY RELAY CONTACTS

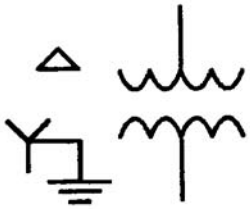


T.D.D.O.

(TIME DELAY TO DROP-OUT)
(WHEN COIL DE-ENERGIZED)
(N.C. CONTACT)
(TIMES OUT IN 2 MIN.)

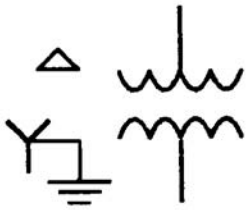
TIME DELAY RELAY CONTACTS

APPENDIX B—CONCLUDED



T1
1000 KVA, OA
13.8 – 480/277V
3 PH, 4W
Z = 5.75%

POWER TRANSFORMER

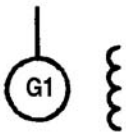


T2
25KVA
480 -- 120/208\
3Φ, 4W

DRY TYPE TRANSFORMER

CB1
1200A
(1600 A)
LTD & IT
60,000 AIC

DRAW-OUT AIR CIRCUIT BREAKER



G1
30,000KW
0.85 PF, 13.8
3 PH, 60 H
3600 RPM

GENERATOR

CB1
600A
(800A)
30,000 AIC

MOLDED-CASE CIRCUIT BREAKER

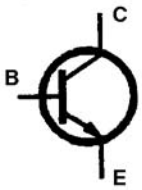
10 HP
3Φ, 460V, 60 H
1800 RPM

AIR HANDLING UNIT NO. 7

MOTOR

F8
60A
10,000 AIC
RES 60

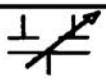
FUSE



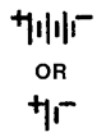
Q3
2N335
1ST IF

SEMICONDUCTOR

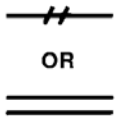
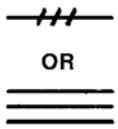
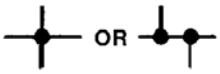
APPENDIX C
GRAPHICS SYMBOLS AND CLASS DESIGNATION LETTERS FOR ELECTRICAL AND ELECTRONIC DIAGRAMS FUNDAMENTAL ITEMS

SYMBOL DESCRIPTION	CLASS DESIGNA-TOR	SYMBOL
FIXED CAPACITOR (GENERAL)	C	
POLARIZED CAPACITOR	C	
SHIELDED CAPACITOR	C	
ADJUSTABLE OR VARIABLE CAPACITOR	C	
CONTINUOUSLY, ADJUSTABLE OR VARIABLE DIFFERENTIAL	C	
SPLIT-STATOR CAPACITOR	C	
FEED-THROUGH CAPACITOR	C	
RESISTOR, FIXED (GENERAL WITH TERMINALS)	R	
RESISTOR, FIXED (GENERAL)	R	
RESISTOR, VARIABLE (ADJUSTABLE)	R	
RESISTOR, VARIABLE (ADJUSTABLE WITH TERMINALS)	R	

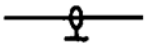
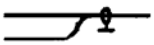
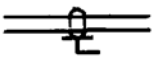
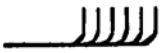
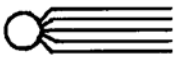
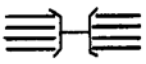
APPENDIX C -- CONTINUED
FUNDAMENTAL ITEMS

SYMBOL DESCRIPTION	CLASS DESIGNATOR	SYMBOL
BATTERY	BT	 OR
THERMOCOUPLE	TC	
QUARTZ CRYSTAL	Y	
SAFETY INTERLOCK (NORMALLY CLOSED)	S	
SAFETY INTERLOCK (NORMALLY OPEN)	S	
SHUNT, INSTRUMENT OR RELAY (CENTER HOLES ARE FOR INSTRUMENT)	R	
ELECTRIC SQUIB	SQUIB	
IGNITER	IGNITER	
THERMAL OVERLOAD ELEMENT	OL	
THERMISTOR	RT	
VARISTOR	RV	
RESISTANCE TEMPERATURE DETECTOR	RTD	

APPENDIX C -- CONTINUED
TRANSMISSION PATH

SYMBOL DESCRIPTION	CLASS DESIGNA-TOR	SYMBOL
BUS BAR (WITH CONNECTION SHOWN)		
CONDUCTIVE PATH OR CONDUCTOR		
TWO CONDUCTORS OR CONDUCTIVE PATHS		
THREE CONDUCTORS OF CONDUCTIVE PATHS		
AIR OR SPACE PATH		
CROSSING OF PATHS OR CONDUCTORS NOT CONNECTED		
JUNCTION		
JUNCTION OF PATHS		
SPLICE		

APPENDIX C -- CONTINUED
TRANSMISSION PATH

SYMBOL DESCRIPTION	CLASS DESIGNA-TOR	SYMBOL
SPLICE		
SHIELDED SINGLE CONDUCTOR OR CABLE (SHIELD DEAD-ENDED)		
SHIELDED TWO CONDUCTOR (SHIELD DEAD-ENDED)		
SHIELDED TWO CONDUCTOR CABLE, WITH CONNECTION TO SHIELD (ADD CONDUCTORS AS REQUIRED)		
SHIELDED TWO CONDUCTOR CABLE (ADD CONDUCTORS AS REQUIRED)		
SHIELDED TWO CONDUCTOR CABLE (SHIELD DEAD-ENDED) (ADD CONDUCTORS AS REQUIRED)		
SHIELDED TWO CONDUCTOR CABLE, TWISTED, (SHIELD DEAD-ENDED) (ADD CONDUCTORS AS REQUIRED)		
COAX CABLE (GENERAL)		
TWO CONDUCTOR COAXIAL (BALANCED WITH ONE OUTER- CONDUCTOR CONNECTION ITWINAX)		
COAXIAL CABLE, ONE CONDUCTOR WITH OUTER-CONDUCTOR CONNECTION AND AND ONE SHIELDED CONNECTION (TRIAX)		
GROUPING OF LEADS (GENERAL)		
GROUPING OF LEADS (GENERAL)		
INTERRUPTION OF CONDUCTOR'S ON DIAGRAM		

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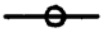
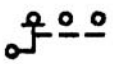
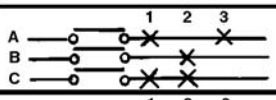
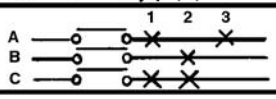
APPENDIX C -- CONTINUED
TRANSMISSION PATH

SYMBOL DESCRIPTION	CLASS DESIGNA-TOR	SYMBOL
CONDUCTOR OR CABLE END, NOT CONNECTED		
CABLE UNDERGROUND; UNDERGROUND LINE		
OVERHEAD LINE		
TERMINATIONS OPEN CIRCUIT		
CIRCUIT RETURN GROUND	GND	
CHASSIS OR FRAME GROUND	GND	
CIRCUIT RETURN, GROUND TO BE USED WHEN IDENTICALLY ANNOTATED COMMON-RETURN CONNECTIONS ARE AT THE SAME POTENTIAL LEVEL.	GND	

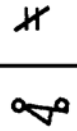
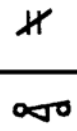
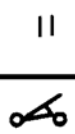
APPENDIX C--CONTINUED
CONTACTS, SWITCHES, CONTRACTORS, AND RELAYS

SYMBOL DESCRIPTION	CLASS DESIGNA-TOR	SYMBOL
NORMALLY OPEN	K	 OR 
NORMALLY CLOSED	K	 OR 
TIME DELAY OPENING (WHEN COIL IS ENERGIZED)	K	
TIME DELAY OPENING (WHEN COIL IS DE-ENERGIZED)	K	
RELAY COIL	K	

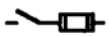
APPENDIX C -- CONTINUED
CONTACTS, SWITCHES, CONTACTORS, AND RELAYS

SYMBOL DESCRIPTION	CLASS DESIGNA-TOR	SYMBOL
TOGGLE (SPDT)	S	
ROTARY (BREAK-BEFORE-MAKE)	S	
ROTARY (MAKE-BEFORE-BREAK)	S	
PUSHBUTTON (MOMENTARY - N.O.)	S	
PUSHBUTTON (MOMENTARY - N.C.)	S	
PUSHBUTTON (MOM. – SDT)	S	
PUSHBUTTON (ALTERNATE ACTION)	S	
MAINTAINED CONTACT	S	
COMPLEX SWITCH (SHOWN: 3 POLES, 3 POSITION, X=CLOSURE)(N.O.)	S	
COMPLEX SWITCH (SHOWN: 3 POLES, 3 POSITION, X=CLOSURE)(N.C.)	S	
LIMIT SWITCH (N. O.)	LS	
LIMIT SWITCH (N. O.)	LS	

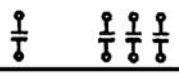
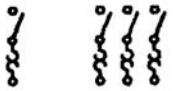
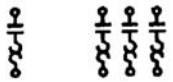
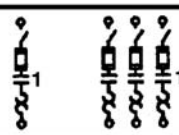
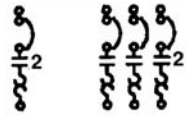
APPENDIX C -- CONTINUED
CONTACTS, SWITCHES, CONTACTORS, AND RELAYS

SYMBOL DESCRIPTION	CLASS DESIGNA-TOR	SYMBOL
LIMIT SWITCH (N. O., HELD CLOSED, ACTUATED)	LS	
LIMIT SWITCH (N. C.)	LS	
LIMIT SWITCH (N. C., HELD OPEN, ACTUATED)	LS	
FLOW SWITCH (CLOSES ON INCREASE IN FLOW)	FS	
FLOW SWITCH (OPENS ON INCREASE IN FLOW)	FS	
LIQUID LEVEL SWITCH (CLOSES ON RISING LEVEL)	LLS	
LIQUID LEVEL SWITCH (OPENS ON RISING LEVEL)	LLS	
PRESSURE OR VACUUM SWITCH (CLOSES ON RISING PRESSURE)	PS	
PRESSURE OR VACUUM SWITCH (OPENS ON RISING PRESSURE)	PS	

APPENDIX C -- CONTINUED
CONTACTS, SWITCHES, CONTACTORS, AND RELAYS

SYMBOL DESCRIPTION	CLASS DESIGNATOR	SYMBOL
TEMPERATURE SWITCH (CLOSES ON RISING TEMPERATURE)	TS	
TEMPERATURE SWITCH (OPENS ON RISING TEMPERATURE)	TS	
KEY OPERATED SWITCH	KS	
KEY INTERLOCK (SELECTOR) (PUSHBUTTON ACTION)	KS	
FUSED DISCONNECT SWITCH	DS	 OR 
TORQUE SWITCH (OPENS WHEN TORQUE SETTING IS EXCEEDED)	S	
UNFUSED DISCONNECT SWITCH (SINGLE POLE)	DSC	
UNFUSED DISCONNECT SWITCH (3 POLE)	DSC	
FOOT OPERATED SWITCH (OPEN BY FOOT PRESSURE)	FTS	
FOOT OPERATED SWITCH (CLOSES BY FOOT PRESSURE)	FTS	
HOOK SWITCH	HS	

APPENDIX C -- CONTINUED
CONTACTS, SWITCHES, CONTACTORS, AND RELAYS

SYMBOL DESCRIPTION	CLASS DESIGNA-TOR	SYMBOL
MAGNETIC CONTACTOR	MC	(1Φ) (3Φ) 
MOTOR STARTER, MANUAL	MS	
MOTOR STARTER, FULL VOLTAGE	MS	
MOTOR STARTER, COMBINATION W/FUSED DISCONNECT SWITCH, NEMA SIZE 1	MS OR CS	
MOTOR STARTER, COMBINATION CIRCUIT BREAKER TYPE, NEMA SIZE 2	MS OR CS	

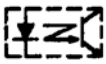
APPENDIX C -- CONTINUED
TERMINALS AND CONNECTORS

SYMBOL DESCRIPTION	CLASS DESIGNA-TOR	SYMBOL
TERMINAL BLOCK	TB	
TERMINAL STRIP	TS	
JACK OR RECEPTACLE (SINGLE)	J	
PLUG CONTACT (MALE) (SINGLE)	P	
JACK (FEMALE) / PLUG (MALE) CONTACT (ENGAGED)	J (FEMALE) P (MALE)	
JACK OR RECEPTACLE (WIRING DIAGRAM APPLICATION)	J	
PLUG (MALE) CONTACT (WIRING DIAGRAM APPLICATION)	P	
COAXIAL JACK OR RECEPTACLE (FEMALE)	J	
COAXIAL PLUG (MALE)	P	
TEST POINT	TP	 
POWER CONNECTOR, 125V 15A, FEMALE	J	
POWER CONNECTOR, 125V, 15A, MALE	P	

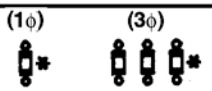
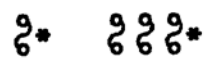
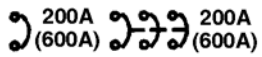
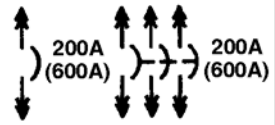
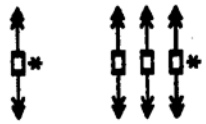
APPENDIX C -- CONTINUED
TRANSFORMERS

SYMBOL DESCRIPTION	CLASS DESIGNA-TOR	SYMBOL
INDUCTOR, AIR CORE	T	
INDUCTOR, IRON CORE	T	
INDUCTOR, VARIABLE	T	
INDUCTOR, TAPPED	T	
TRANSFORMER (GENERAL)	T	
TRANSFORMER (WITH CORE)	T	
AUTO-TRANSFORMER	T	
AUTO-TRANSFORMER, ADJUSTABLE	T	

APPENDIX C -- CONTINUED
SEMICONDUCTORS

SYMBOL DESCRIPTION	CLASS DESIGNATOR	SYMBOL
DIODE	CR OR D	
DIODE, ZENER	VR	
DIODE, TUNNEL	VR	
DIODE, LIGHT EMITTING	LED	
BRIDGE RECTIFIER (FULL WAVE)		
SEMICONDUCTOR CONTROLLED RECTIFIER	SCR	
TRIAC	Q	
OPTICAL ISOLATOR		
TRANSISTOR, PNP	Q	
TRANSISTOR, NPN	Q	
UNIJUNCTION TRANSISTOR, N CHANNEL	Q	
FIELD EFFECT TRANSISTOR, N CHANNEL	Q	

APPENDIX C -- CONTINUED
CIRCUIT PROTECTORS

SYMBOL DESCRIPTION	CLASS DESIGNA-TOR	SYMBOL
FUSE (* FUSE NUMBER, CURRENT RATING, INTERRUPTING RATING)	F	
FUSE, ALTERNATE (*FUSE NUMBER, CURRENT RATING, INTERRUPTING RATING)	F	
CIRCUIT BREAKER, MOLDED CASE (200A TRIP SETTING, 600A FRAME SIZE)	CB	
CIRCUIT BREAKER, DRAWOUT TYPE, (200A TRIP SETTING, 600A FRAME SIZE)	CB	
FUSE, DRAWOUT TYPE (* FUSE NUMBER, CURRENT RATING, INTERRUPTING RATING)	F	

APPENDIX C -- CONTINUED
ACOUSTIC DEVICES

SYMBOL DESCRIPTION	CLASS DESIGNA-TOR	SYMBOL
HORN, SIREN, ETC. (INSERT H, S, ETC.)	AH OR AS	
BELL	BL	
BUZZER	BZ	
HEADSET	HT	
MICROPHONE	MK	
SPEAKER	HN, HW LS, SN, EM	

APPENDIX C -- CONTINUED
SIGNALING SYSTEM--INTERCOM

SYMBOL DESCRIPTION	CLASS DESIG-NATOR	SYMBOL
INTERCOM STATION HAZARDOUS AREAS	IC	
INTERCOM STATION DESK TOP MOUNT	IC	
INTERCOM STATION RACK MOUNT	IC	
INTERCOM STATION TWO PIECE	IC	
INTERCOM STATION TAC CONSOLE MOUNTING	IC	
INTERCOM STATION WALL MOUNT, INDOOR	IC	
INTERCOM STATION WALL MOUNT, OUTDOOR	IC	
INTERCOM AMPLIFIER	A OR AR	
INTERCOM HEADSET		
INTERCOM MICROPHONE	MK	
INTERCOM SPEAKER, INTERIOR/EXTERIOR (ADD APPROPRIATE DESIG. IE, HN, HW, LS, ETC.)		
ANY OTHER ITEM ON SAME SYSTEM, USE NUMBERS AS REQUIRED		

* Decimal number indicates CAD symbol scaled for that drawing grid.

APPENDIX C -- CONTINUED
LAMPS AND VISUAL --SIGNALING DEVICES

SYMBOL DESCRIPTION	CLASS DESIGNA-TOR	SYMBOL	
INCANDESCENT LAMP (INSERT COLOR, I.E., R-RED, Y-YELLOW G-GREEN, B-BLUE, ETC.)	L		
INCANDESCENT LAMP (INSERT COLOR, I.E., R-RED, Y-YELLOW G-GREEN, B-BLUE, ETC.)	L		
INCANDESCENT LAMP (INSERT COLOR, I.E., R-RED, Y-YELLOW G-GREEN, B-BLUE, ETC.)	L		
INCANDESCENT LAMP (INSERT COLOR I.E., R-RED, Y-YELLOW G-GREEN, B-BLUE, ETC.)	L		
NEON LAMP – AC	DS		
NEON LAMP – DC	DS		
FLUORESCENT LAMP (TWO TERMINAL)	FL		
FLUORESCENT LAMP (FOUR TERMINAL)	FL		
LIGHT EMITTING DIODE (LEO)	LED		

NOTE:

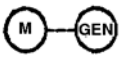
IF IT IS ESSENTIAL TO INDICATE THE FOLOWING CHARACTERISTICS, THE SPECIFIED LETTER OR LETTERS MAY BE INSERTED WITHIN OR PLACED ADJACENT TO THE SYMBOL.

A--AMBER	P--PURPLE	ARC	ARC	NA	SODIUM VAPOR
B--BLUE	R--RED	EL	ELECTROLUMINESCENT	NE	NEON
C--CLEAR	W--WHITE	FL	FLUORESCENT	UV	ULTRAVIOLET
G--GREEN	Y--YELLOW	HG	MERCURY VAPOR	XE	XENON
O--ORANGE		IN	INCANDESCENT	LED	LIGHT-EMITTING DIODE
OP--OPALESCENT		IR	INFRARED		

APPENDIX C -- CONTINUED
READOUT DEVICES

SYMBOL DESCRIPTION	CLASS DESIGNATOR	SYMBOL
METER	SEE LISTING UNDER SYMBOL	
		NOTE: THE ASTERISK IS NOT PART OF THE SYMBOL. ALWAYS REPLACE THE ASTERISK BY ONE OF THE FOLLOWING LETTER COMBINATIONS, DEPENDING ON THE FUNCTION OF THE METER OR INSTRUMENT, UNLESS SOME OTHER IDENTIFICATION IS PROVIDED IN THE CIRCLE AND EXPLAINED ON THE DIAGRAM.
		A Ammeter AH Ampere-hour meter C Columbmeter CMA Contact-making (or breaking) ammeter CMC Contact-making (or breaking) clock CMV Contact-making (or breaking) volmeter CRO Oscilloscope, Cathode-ray oscillograph DB DB (decibel) meter, Audio level/meter DBM DBM (decibels referred to 1 millwatt) meter DM Demand meter DTR Demand-totalizing relay F Frequency meter GD Ground detector I Indicating meter INT Integrating meter μA or UA Microammeter MA Milliammeter NM Noise meter OHM Ohmmeter OP Oil pressure meter OSCG Oscillograph, string PF Power factor meter PH Phasemeter PI Position Indicator RD Recording demand meter REC Recording meter RF Reactive factor meter SY Synchroscope t° Temperature meter THC Thermal converter TLM Telemeter TT Total time meter, Elapsed time meter V Volmeter VA Volt-ammeter VARH Varhour meter VI Volume indicator, Audio-level meter VU Standard volume indicator, Audio-level meter W Wattmeter WH Watthour meter

APPENDIX C -- CONCLUDED
ROTATING MACHINERY

SYMBOL DESCRIPTION	CLASS DESIGNA-TOR	SYMBOL
MOTOR OR GENERATOR, SINGLE PHASE, AC, (INSERT HORSEPOWER OR KVA RATING)	M OR G	
MOTOR OR GENERATOR, THREE PHASE, AC, (INSERT HORSEPOWER OR KVA RATING)	M OR G	
MOTOR, DC ARMATURE (INSERT HORSEPOWER OR KVA RATING)	M OR G	
FIELD, MOTOR OR GENERATOR	FLD	
MOTOR GENERATOR	MG	

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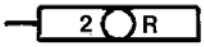
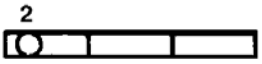
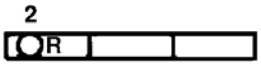
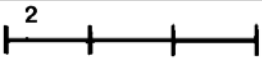
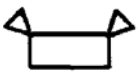
APPENDIX D
GRAPHICS SYMBOLS AND CLASS DESIGNATION LETTERS FOR ELECTRICAL ARCHITECTURAL LAYOUT AND WIRING OUTLETS

SYMBOL DESCRIPTION	CLASS DESIGNATOR	SYMBOL
LIGHTING, RECEPTACLE, SWITCH & SIGNALING SYSTEM OUTLETS	SEE LISTING UNDER SYMBOL	* ◯ NOTE: THIS SYMBOL REPRESENTS ANY TYPE OF OUTLET NOTE: THE ASTERISK IS NOT PART OF THE SYMBOL. ALWAYS REPLACE THE ASTERISK BY ONE OF THE FOLLOWING LETTER COMBINATIONS, DEPENDING ON THE TYPE OF OUTLET. WP WEATHERPROOF VT VAPORTIGHT WT WATERTIGHT RT RAINTIGHT DT DUSTTIGHT EP EXPLOSION PROOF G GROUNDED R RECESSED UNG UNGROUNDED IG ISOLATED GROUND

APPENDIX D -- CONTINUED
LIGHTING OUTLETS

SYMBOL DESCRIPTION	CLASS DESIGNA-TOR	SYMBOL
SURFACE OR PENDANT INCANDESCENT, CEILING, (CIRCUIT 2)		
SURFACE OR PENDANT INCANDESCENT, WALL, (CIRCUIT 2)		
RECESSED INCANDESCENT, OR SIMILAR FIXTURE, CEILING, (CIRCUIT 2)		
RECESSED INCANDESCENT, OR SIMILAR FIXTURE, WALL, (CIRCUIT 2)		
SURFACE OR PENDANT INDIVIDUAL FLUORESCENT, CEILING, (CIRCUIT 2)		
SURFACE OR PENDANT INDIVIDUAL FLUORESCENT, WALL, (CIRCUIT 2)		
RECESSED INDIVIDUAL FLUORESCENT, CEILING, (CIRCUIT 2)		
RECESSED INDIVIDUAL FLUORESCENT, WALL, (CIRCUIT 2)		
SURFACE OR PENDANT CONTINUOUS ROW FLUORESCENT, (CIRCUIT 2)		
RECESSED CONTINUOUS ROW FLUORESCENT, (CIRCUIT 2)		
BARE-LAMP FLUORESCENT STRIP		
EMERGENCY EXIT LIGHTS (BATTERY BACKED)		

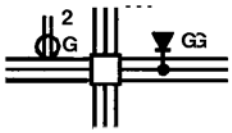
APPENDIX D -- CONTINUED
RECEPTACLE OUTLETS

SYMBOL DESCRIPTION	CLASS DESIG-NATOR	SYMBOL
SURFACE OR PENDANT EXIT LIGHT, CEILING, (CIRCUIT 2)		(X)2
SURFACE OR PENDANT EXIT LIGHT, WALL, (CIRCUIT 2)		-(X)2
RECESSED EXIT LIGHT, CEILING, (CIRCUIT 2)		(RX)2
RECESSED EXIT LIGHT, WALL, (CIRCUIT 2)		-(RX)2
JUNCTION BOX, CEILING, (CIRCUIT 2)		(J)2
JUNCTION BOX, WALL, (CIRCUIT 2)		-(J)2
CONTROLLED OUTLET WITH LOW VOLTAGE RELAY IN BOX, CEILING, (CIRCUIT 2)		(L)2
CONTROLLED OUTLET WITH LOW VOLTAGE RELAY IN BOX, WALL, (CIRCUIT 2)		-(L)2

APPENDIX D -- CONTINUED
RECEPTACLE OUTLETS

SYMBOL DESCRIPTION	CLASS DESIGNA-TOR	SYMBOL
SINGLE RECEPTACLE OUTLET, (CIRCUIT 2)		
DUPLEX RECEPTACLE OUTLET, (CIRCUIT 2)		
TRIPLEX RECEPTACLE OUTLET, (CIRCUIT 2)		
QUADRUPLEX RECEPTACLE OUTLET, (CIRCUIT 2)		
DUPLEX RECEPTACLE OUTLET, SPLIT WIRED, (CIRCUIT 2)		
TRIPLEX RECEPTACLE OUTLET, SPLIT WIRED, (CIRCUIT 2)		
SINGLE SPECIAL PURPOSE RECEPTACLE OUTLET, (CIRCUIT 2)		
DUPLEX SPECIAL PURPOSE RECEPTACLE OUTLET, (CIRCUIT 2)		
RANGE RECEPTACLE OUTLET, (CIRCUIT 2)		
SPECIAL PURPOSE RECEPTACLE OUTLET, USE DW FOR DISHWASHER, CD FOR CLOTHES DRYER, ETC., (CIRCUIT 2)		
CLOCK HANGER RECEPTACLE OUTLET, (CIRCUIT 2)		

APPENDIX D -- CONTINUED
RECEPTACLE OUTLETS

SYMBOL DESCRIPTION	CLASS DESIGNA-TOR	SYMBOL
FLOOR SINGLE RECEPTACLE OUTLET, (CIRCUIT 2)		
FLOOR DUPLEX RECEPTACLE OUTLET, (CIRCUIT 2)		
FLOOR TELEPHONE OUTLET		
UNDERFLOOR DUCT WITH DUPLEX RECEPTACLE OUTLET, (CIRCUIT 2), AND TELEPHONE OUTLET (BOTH GROUNDED)		

NOTES:
1. Identify grounding-type receptacle outlets with letter "G". Omit letter "G" for non-grounding receptacle outlets.
2. Asterisk is not part of symbol. Asterisk indicates point to place subscript keyed tc explanation in the drawing list of symbols to indicate type of receptacle or usage.

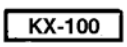
APPENDIX D -- CONTINUED
SWITCH OUTLETS

SYMBOL DESCRIPTION	CLASS DESIGNA-TOR	SYMBOL
SINGLE POLE SWITCH	S	S
DOUBLE POLE SWITCH	S	S_2
THREE-WAY SWITCH	S	S_3
FOUR-WAY SWITCH	S	S_4
KEY-OPERATED SWITCH	S	S_K
SWITCH AND PILOT LAMP	S	S_P
SWITCH FOR LOW-VOLTAGE SWITCHING SYSTEM	S	S_L
MASTER SWITCH FOR LOW-VOLTAGE SWITCHING SYSTEM	S	S_M
MASTER SWITCH FOR LOW-VOLTAGE SWITCHING SYSTEM	S	S_{LM}
SWITCH AND SINGLE RECEPTACLE (CIRCUIT 2)	S	
SWITCH AND DOUBLE RECEPTACLE (CIRCUIT 2)	S	

APPENDIX D -- CONTINUED
SWITCH OUTLETS

SYMBOL DESCRIPTION	CLASS DESIGNA-TOR	SYMBOL
DOOR SWITCH		S_D
TIME SWITCH		S_T
CIRCUIT BREAKER SWITCH		S_{CB}
MOMENTARY CONTACT SWITCH		S_{MC}
CEILING PULL SWITCH		(S)

APPENDIX -- CONTINUED
SIGNALING SYSTEM -- FIRE ALARM

SYMBOL DESCRIPTION	CLASS DESIGNATOR	SYMBOL
FIRE DETECTOR BATTERY TYPE		
SMOKE DETECTOR BATTERY TYPE		
ZONE INDICATOR UNIT		
FIRE INDICATOR UNIT		
FIRE ALARM BELL	FA	
FIRE ALARM BUZZER	BZ	
FIRE ALARM MANUAL PULL STATION	F	
FIRE ALARM HORN/SIREN INSERT H,S, ETC.	H S	
FIRE ALARM CABNET NETWORK	F/AC	
FIRE ALARM TRANSCEIVER FACILITY TRANSMITTER		
FIRE ALARM INTERFACE		
FIRE ALARM ANTENNA	ANT	

APPENDIX D -- CONTINUED
SIGNALING SYSTEM -- FIRE ALARM

SYMBOL DESCRIPTION	CLASS DESIGNATOR	SYMBOL
POWER DISCONNECT SWITCH	PDSW	PDSW
FIRE ALARM MANUAL PULL STATION (EXTERIOR)	F EXT.	F EXT
FIRE ALARM MANUAL PULL STATION (EXPLOSION PROOF)	EP	F EP
FIRE ALARM DETECTOR SMOKE CEILING (1-2 INDICATES ZONE AND NUMBER)	SC	SC 1–2
FIRE ALARM DETECTOR SMOKE FLOOR (2-2 INDICATES ZONE AND NUMBER)	SU	SU 2–2
FIRE ALARM DETECTOR PRESSURE	DP	DP
FIRE ALARM DETECTOR TEMPERATURE	DT	DT
FIRE ALARM DETECTOR HUMIDITY	DH	DH
FIRE ALARM DETECTOR RATE OF RISE	DR	DR
FIRE ALARM DETECTOR ANY AUTOMATIC TYPE	FA	FA
SOLENOID VALVE (2 INDICATES UNIT NUMBER)	SV	SV 2
ABORT PUSHBUTTON SWITCH	PB	PB

APPENDIX D -- CONTINUED
SIGNALING SYSTEM -- FIRE ALARM

SYMBOL DESCRIPTION	CLASS DESIGNATOR	SYMBOL
HALON ABORT STATION	HA	HA
HALON RELEASE STATION	HR	HR
HALON RELEASE STATION	HR	HR
WATER FLOW SWITCH DETECTOR	WF	WF
OVERRIDE SWITCH	OVR	OVR
OVERRIDE OF HALON DISCHARGE	OVR H	OVR H
OVERRIDE OF HALON DISCHARGE AND POWER SHUTDOWN	OVR HP	OVR HP
FIRE DAMPER CONTROL	FD	FD
AIR HANDLING UNIT	AHU	AHU

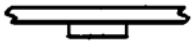
APPENDIX D -- CONTINUED
SIGNALING SYSTEM -- INTERCOM AND TELEPHONE

SYMBOL DESCRIPTION	CLASS I DESIGNATOR	SYMBOL
INTERCOM STATION HAZARDOUS AREAS	IC	
INTERCOM STATION DESK TOP MOUNT	IC	
INTERCOM STATION RACK MOUNT	IC	
INTERCOM STATION TWO PIECE	IC	
INTERCOM STATION TAC CONSOLE MOUNTING	IC	
INTERCOM STATION WALL MOUNT, INDOOR	IC	
INTERCOM STATION WALL MOUNT, OUTDOOR	IC	
INTERCOM AMPLIFIER	A OR AR	
INTERCOM MICROPHONE	IC	
INTERCOM SPEAKER, INTERIOR (ADD APPROPRIATE DESIG. IE, HN, HW, LS, ETC.)		
INTERCOM SPEAKER, EXTERIOR (ADD APPROPRIATE DESIG. (IE, HN, HW, LS, ETC.)		
ANY OTHER ITEM ON SAME SYSTEM, USE NUMBERS AS REQUIRED		
TELEPHONE		

APPENDIX D -- CONTINUED
SIGNALING SYSTEM -- RESIDENTIAL OCCUPANCIES

SYMBOL DESCRIPTION	CLASS DESIGNA-TOR	
HORN, SIREN, ETC. (INSERT H, S, ETC.)	AH OR AS	
BELL	BL	
BUZZER	BZ	
ELECTRIC DOOR OPENER		
MAID'S SIGNAL PLUG		
INTERCONNECTION BOX		
BELL RINGING TRANSFORMER		
RADIO OUTLET		
TELEVISION OUTLET		

APPENDIX D -- CONTINUED
PANELBOARDS, SWITCHBOARDS AND RELATED EQUIPMENT

SYMBOL DESCRIPTION	CLASS DESIGNA-TOR	SYMBOL
PANELBOARD, FLUSH MOUNTED		
PANELBOARD, SURFACE MOUNTED		
SWITCHBOARD, POWER CONTROL CENTER, UNIT SUBSTATIONS		
TERMINAL CABINET, FLUSH MOUNTED		
TERMINAL CABINET, SURFACE MOUNTED		
PULL BOX	PB	
MOTOR OR OTHER POWER CONTROLLER	MC	
DISCONNECT SWITCH EXTERNALLY OPERATED	DS	
COMBINATION CONTROLLER AND DISCONNECT SWITCH	CS	
COMBINATION CONTROLLER AND CIRCUIT BREAKER		

APPENDIX D -- CONTINUED
BUS DUCT AND WIREWAYS

SYMBOL DESCRIPTION	CLASS DESIGNA-TOR	SYMBOL
TROLLY DUCT		
BUSWAY (SERVICE, FEEDER, OR PLUG-IN)		
CABLE TROUGH, LADDER, OR CHANNEL		
WIREWAY		

APPENDIX D -- CONTINUED
REMOTE CONTROL STATIONS FOR MOTORS AND OTHER EQUIPMENT

SYMBOL DESCRIPTION	CLASS DESIGNA-TOR	SYMBOL
PUSHBUTTON STATIONS IN GENERAL		
FLOAT SWITCH, MECHANICAL		
LIMIT SWITCH, MECHANICAL		
PNEUMATIC SWITCH, MECHANICAL		
ELECTRIC EYE, BEAM SOURCE		
ELECTRIC EYE, RELAY		
THERMOSTAT		

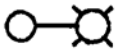
APPENDIX D -- CONTINUED
CIRCUITING

SYMBOL DESCRIPTION	CLASS DESIG-NATOR	SYMBOL
WIRING CONCEALED IN CEILING OR WALL		
WIRING CONCEALED IN FLOOR		
WIRING EXPOSED		
CROSS LINES INDICATE NUMBER OF WIRES, NO CROSSES INDICATE 2 #12 WIRES		
BRANCH CIRCUIT HOME RUN TO PANELBOARD LP, CIRCUITS #1 & #3, CROSS LINES INDICATE NUMBER OF WIRES		LP1-1,3
INDICATE EMPTY CONDUIT BY NOTATION CO (CONDUIT ONLY)		3/4" CO
CONDUCTOR AND CONDUIT SIZE INDICATION, WITH A GROUND WIRE		3 #10, #10G, 3/4"C.
WIRING OR CONDUIT TURNING UP OR TOWARD THE OBSERVER		
WIRING OR CONDUIT TURNING DOWN OR AWAY FROM THE OBSERVER		

APPENDIX D -- CONTINUED
ELECTRICAL DISTRIBUTION OR LIGHTING SYSTEM UNDERGROUND

SYMBOL DESCRIPTION	CLASS DESIGNA-TOR	SYMBOL
MANHOLE	M	M
HANDHOLE	H	H
TRANSFORMER MANHOLE OR VAULT	TM	TM
TRANSFORMER PAD	TP	TP
UNDERGROUND DIRECT BURIAL CABLE		
UNDERGROUND DUCT LINE		

APPENDIX D -- CONCLUDED
ELECTRICAL DISTRIBUTION OR LIGHTING SYSTEM AERIAL

SYMBOL DESCRIPTION	CLASS DESIGNATOR	SYMBOL
POLE		
POLE WITH STREET LIGHT		
POLE WITH DOWN GUY AND ANCHOR		
TRANSFORMER		
HEAD GUY		
SIDEWALK GUY		
SERVICE WEATHERHEAD		

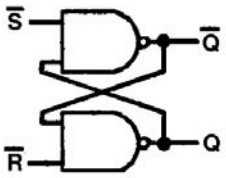
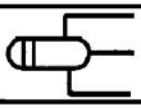
APPENDIX E
GRAPHICS SYMBOLS AND CLASS DESIGNATION LETTERS FOR ELECTRICAL LOGIC FUNCTION DIAGRAMS LOGIC FUNCTIONS

SYMBOL DESCRIPTION	CLASS DESIGNA-TOR	SYMBOL
AND GATE	IC	
HAND GATE (AND GATE WITH NEGATED OUTPUT)	IC	
AND INVERT GATE (NEGATED INPUTS)	IC	
OR GATE	IC	
NOR GATE (OR GATE WITH NEGATED OUTPUT)	IC	
OR INVERT GATE (NEGATED INPUTS)	IC	
NEGATION OR INTERNAL CONNECTIONS		

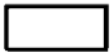
APPENDIX E -- CONTINUED
LOGIC FUNCTIONS

SYMBOL DESCRIPTION	CLASS DESIGNA-TOR	SYMBOL
EXCLUSIVE OR GATE	IC	
FLIP-FLOP, J-K	IC	
ONE SHOT	IC	
SCHIMITT TRIGGER	IC	
BUFFER/DRIVER	IC	
INVERTER	IC	

APPENDIX E -- CONTINUED
LOGIC FUNCTIONS

SYMBOL DESCRIPTION	CLASS DESIGNA-TOR	SYMBOL
CROSS-COUPLED NANDS (R-S FLIP-FLOP)	IC	
OSCILLATOR	IC	
TIME DELAY (SINGLE OUTPUT)	IC	
TIME DELAY (MULTIPLE OUTPUTS)	IC	
OTHER (INSERT DESIGNATOR I.E., CTR-COUNTER, SR-SHIFT REGISTER, ADR-ADDER, ETC.)	IC IC	
AMPLIFIER	IC	

APPENDIX E -- CONCLUDED
LOGIC FUNCTIONS

SYMBOL DESCRIPTION	CLASS DESIGNA-TOR	SYMB0L
INTEGRATOR	IC	
MULTIPLIER	IC	
DIVIDER	IC	
OTHER (USE DESIGNATOR INSIDE)	IC	

12.0 SITE PLAN AND REAL ESTATE DRAWING STANDARDS AND PROCEDURES

12.1 PURPOSE

The purpose of this standard is to delineate the requirements and procedure for sitings and re-sitings of AEDC facilities and the development of site plan and real estate drawings.

12.2 DEFINITIONS

12.2.1 **Site Plan:** A detailed functional drawing which expands on the general site shown on the AEDC General Plan. It indicates the proposed location, orientation, purpose, construction details, and operating limits (if any) for buildings or additions, structures, roads, parking areas, utilities, and provides other information (such as that pertaining to hazards) pertinent to a proposed construction item and its environs. A site plan includes an approval block and specific information. Standard requirements for preparation of site plans are given in the COI 32-5 as well as in 12.5 herein.

12.2.2 **Real Estate Drawing:** A drawing used to show proposed or existing leases, rights-of-way, easements, surveys, and other similar layouts.

12.2.3 **Facility:** The land or real estate, buildings or structures, process machinery, and the supporting equipment and infrastructure (i.e. parking lots, systems, tanks, and utilities).

12.3.4 **Permanent Construction:** A facility suitable and appropriate to serve for a maximum period of time (at least 25 years) and with minimum maintenance.

12.3.5 **Portable Structure:** A building or structure designed to be moved intact from one location to another with or without utility connections. A portable structure is not to be fixed to the ground or to other real property.

12.2.6 **Relocatable Structure:** A building or other structure designed for economical erection or relocation from one site to another, such as temporary classrooms and office or storage buildings.

12.2.7 **Temporary Construction:** A facility suitable and appropriate to fill a need for a short period of time (5 years or less) without regard to degree of maintenance, but with design and detail that provides minimum facilities with maximum initial economies.

12.2.8 **Base Comprehensive Plan:** A term referring to the cumulative data sources in the form of documents and graphics that provide pertinent information used in the planning and decision-making processes. The Comprehensive Plan is comprised of four basic parts: (1) General Plan, (2) Component Plans, (3) Special Plans and Studies, and (4) Maps.

12.2.9 **General Plan:** A decision-makers summary document that contains text, maps, plan graphics, photographs, and other information, in a condensed format.

12.3 SCOPE

These standards (including accompanying procedure) apply to initial sitings and re-sitings of facilities/hazards as described below.

12.3.1 Initial placements of temporary, portable, relocatable, or permanent facilities on previously unused or unoccupied ground where hazards are involved, placements must be coordinated through the proper safety channels. (See Siting Procedure 12.5, steps 6e, 6f, 6g, 6h, and 6i.). Utilities installed in areas previously designated for such need not be sited.

12.3.2 Major modifications or expansions of planned or existing placements if they extend materially beyond previously designated areas.

12.3.2 Significant changes in location of planned or existing placements.

12.3.3 Planned placements with significant internal (or affected by significant external) hazard increases. (Increased hazards in existing placements are handled through waivers, a different procedure, if amounts exceed those specified or inherently allowed by the initial site approved.)

12.4 RELATED STANDARDS

AEDC Safety Standard E-15 provides detailed information used in conjunction with these standards for sitings and re-sitings of facilities for explosives use. The requirements listed in E-15 and AFM 91-201 have been derived from DDESB DoD 6055.9, Explosives Safety Standards, and are mandatory for explosives facilities/operations at AEDC.

12.5 SITING PROCEDURE

Responsibility	Action
Contractor	1. Conducts site study and prepares a plan which describes the proposed facility site in accordance with these standards and procedure.
	2. The Effort C or Effort T project manager or planner initiates facility site planning after the Synergen work request or DD Form 1391 (Military Construction Project Data) is approved by the funding company. The Effort C or Effort T project manager or planner informs the Air Force Project Manager of the site plan requirement. When the request has been approved, the requester initiates NEPA (National Environmental Policy Act) documentation in accordance with AFI 32-7061.

2a. Prepares a Work Request using Synergen. Provides adequate definition of requirements, lead times, and reasonable completion schedules and electronically transmits to Effort C.

Note: Verbal requests will be accepted from the Air Force Realty Officer.

3. Note: Required documentation (e.g., AF Forms 813 and 943) is prepared by the requesting Contractor and submitted to the AF Directly.

Effort C

4. Reviews (or prepares) the site plan for compliance with these standards and procedure and for possible conflicts with current or future plans. Coordinates any conflicts with the organizational units concerned.

5. Assigns a drawing number from Site Plan Log and adds it to the title block. (Revisions are denoted successively: .1, .2, etc., added to the basic number. The basic number is taken from the fiscal year and the order in which site plans are processed for that year. Example: 93-25.3)

If a site plan is prepared by the Effort C for the Effort T, coordinates plan with the requesting Contractor's designated Project Engineer or Job Contact, and obtains approval of the plan.

6. Obtains Contractor site plan approvals/signatures, as follows:

6a. AEDC/Project Manager-For review by AF organization responsible for the specific duty.

6b. Community Planner (Effort C)-Checking for possible conflicting land use proposals and siting concurrence.

6c. Real Property Administrator (Effort C)-Coordinates proper facility numbering according to block layout and check potential conflicts within current and future land constraints.

6d. Safety Office (Effort C)-For compliance with mandatory, accepted, or recommended safety standards. If medical provisions are required, the Safety Office will obtain the concurrence of Industrial Health (Effort C) before approving the drawing.

6e. Safety Office (Effort T)-Facilities proposed within explosive Safety Clear Zones.

6f. Fire Protection Branch (Effort C)-For compliance with mandatory, accepted, or recommended fire protection standards. If security and/or communications provisions are required, Fire Protection will obtain the concurrence of Security and/or Center Communications before approving the drawing.

6g. Security (Effort C)-For facilities exposed to base boundaries, could be potential targets for terrorist activities.

6h. Environmental EIAP (Effort T)-Evaluating for any environmental risk associated with a proposed site.

6i. Envrionmental Compliance (Effort C)-Evaluating for rules and regulations. Make sure no environmental law are broken.

6j. Natural Resources Coordinator (Effort C)-For evaluating and coordinating project activities with the activities of Natural Resources.

Note: Required AF approvals - AEDC/Realty Officer, AEDC/Safety Representative, AEDC/SDE, AEDC/SDF.

7. Obtains a copy of the site plan. Places the reproducible in a temporary active file. Sends one copy of the site plan drawing(s) to the requesting Contractor.

8. Upon approval by the Air Force, files and retains the original site plan drawing.

9. Keeps a record of all site plans processed (includes subsequent revisions).

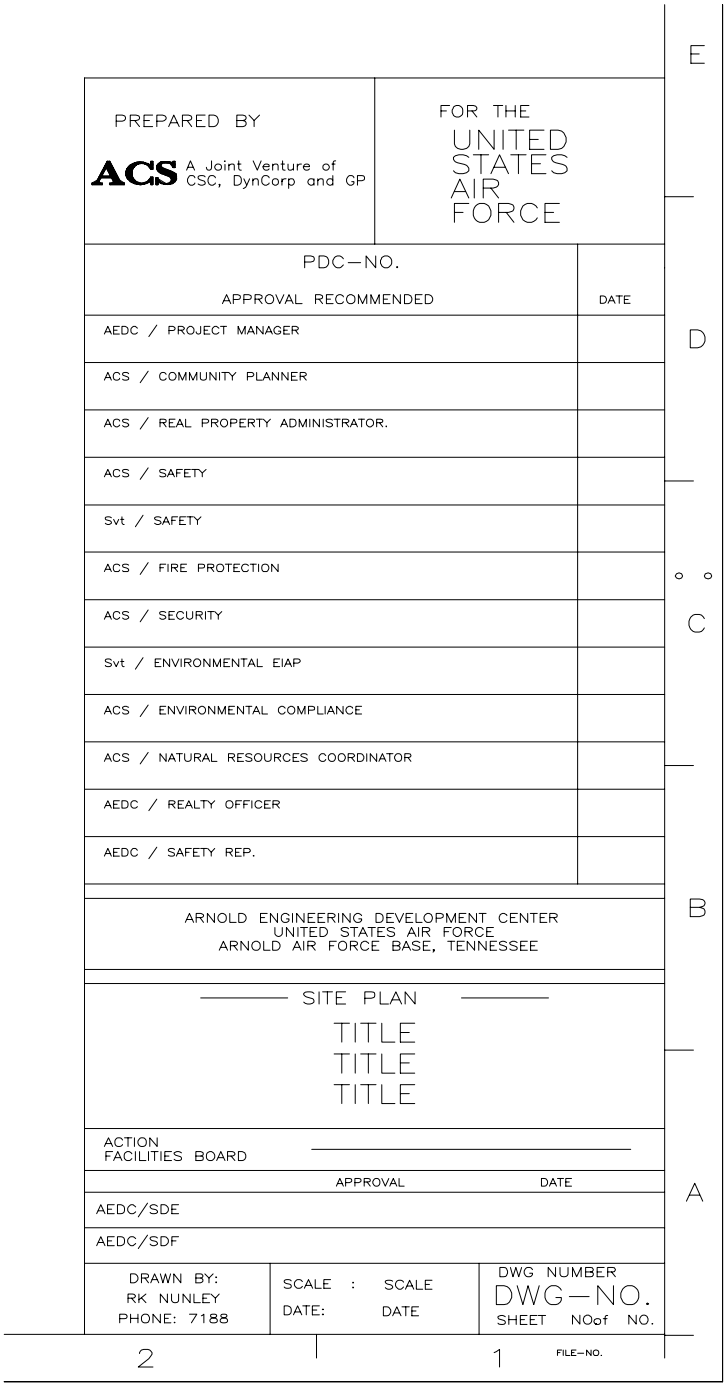


Figure 12.1 Site Plan Title Block

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13.0 **PERSONNEL WARNING DEVICES**

Refer to AEDC Safety Manual Standard B7, AUDIBLE ALARMS AND VISUAL SIGNALS. SIGNALS.

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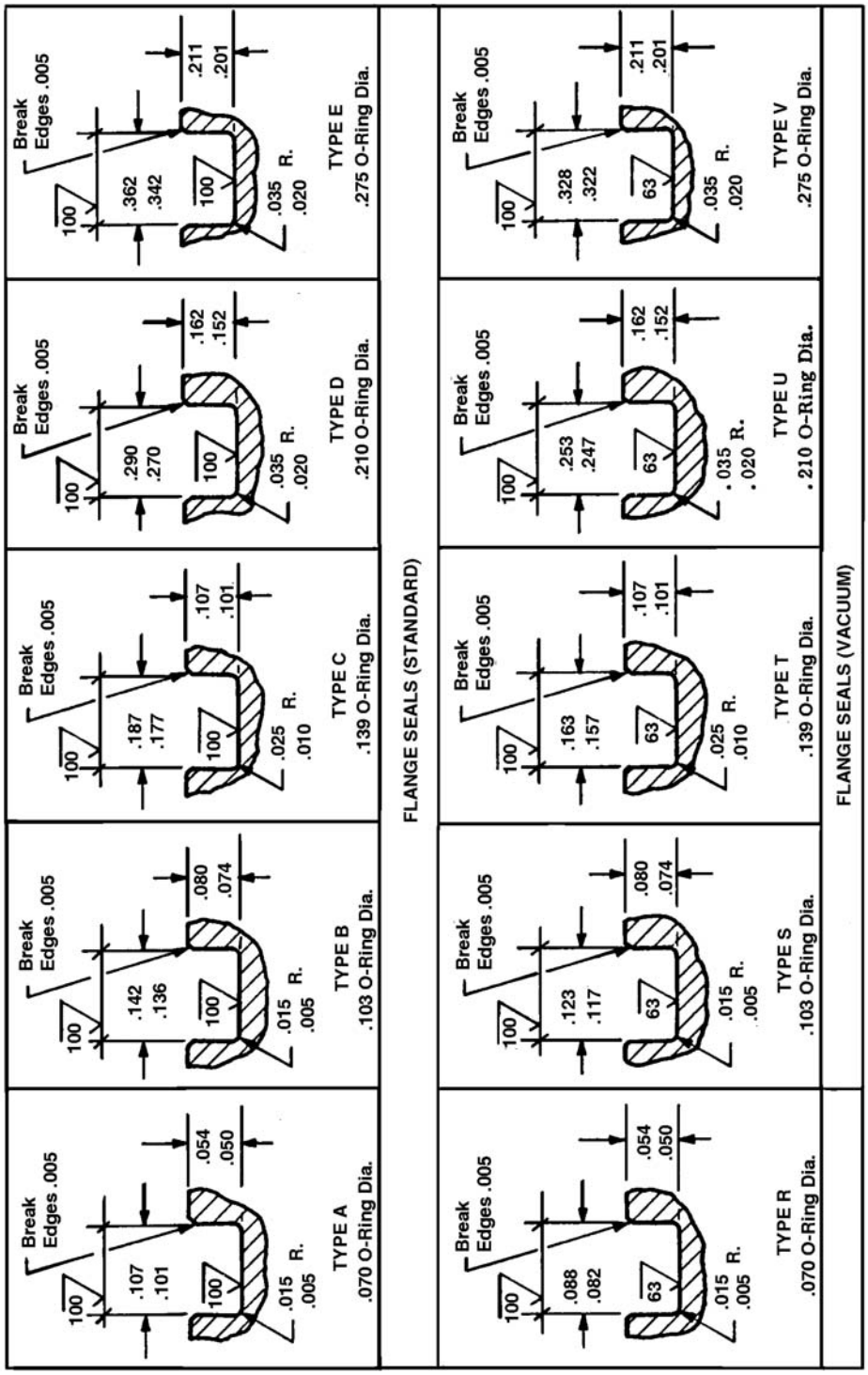
14.0 O-RING STANDARD

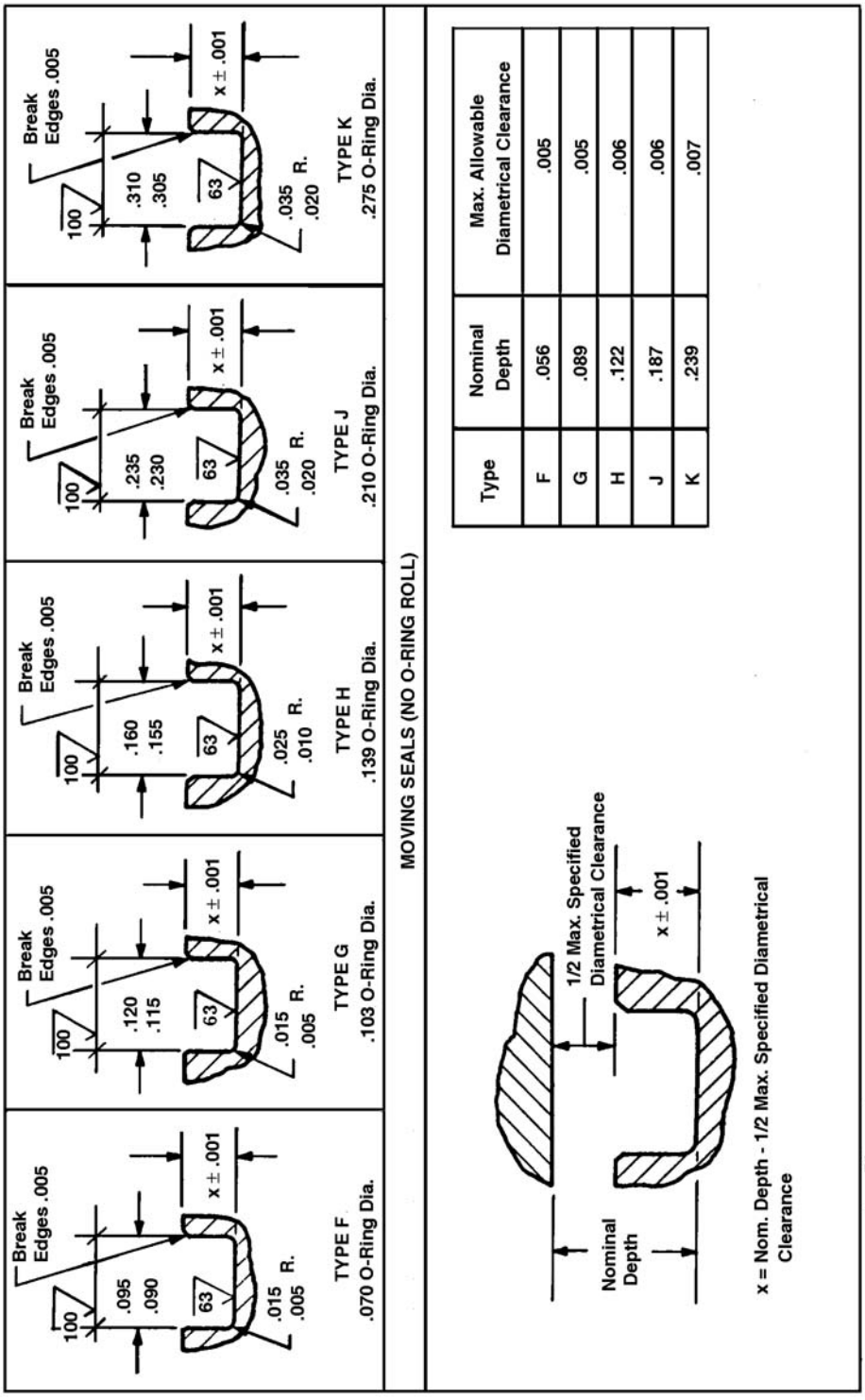
14.1 PURPOSE

The purpose of this standard is to pre-establish groove designs for O-ring seals in order to save drafting time on mechanical drawings prepared at AEDC.

14.2 SCOPE

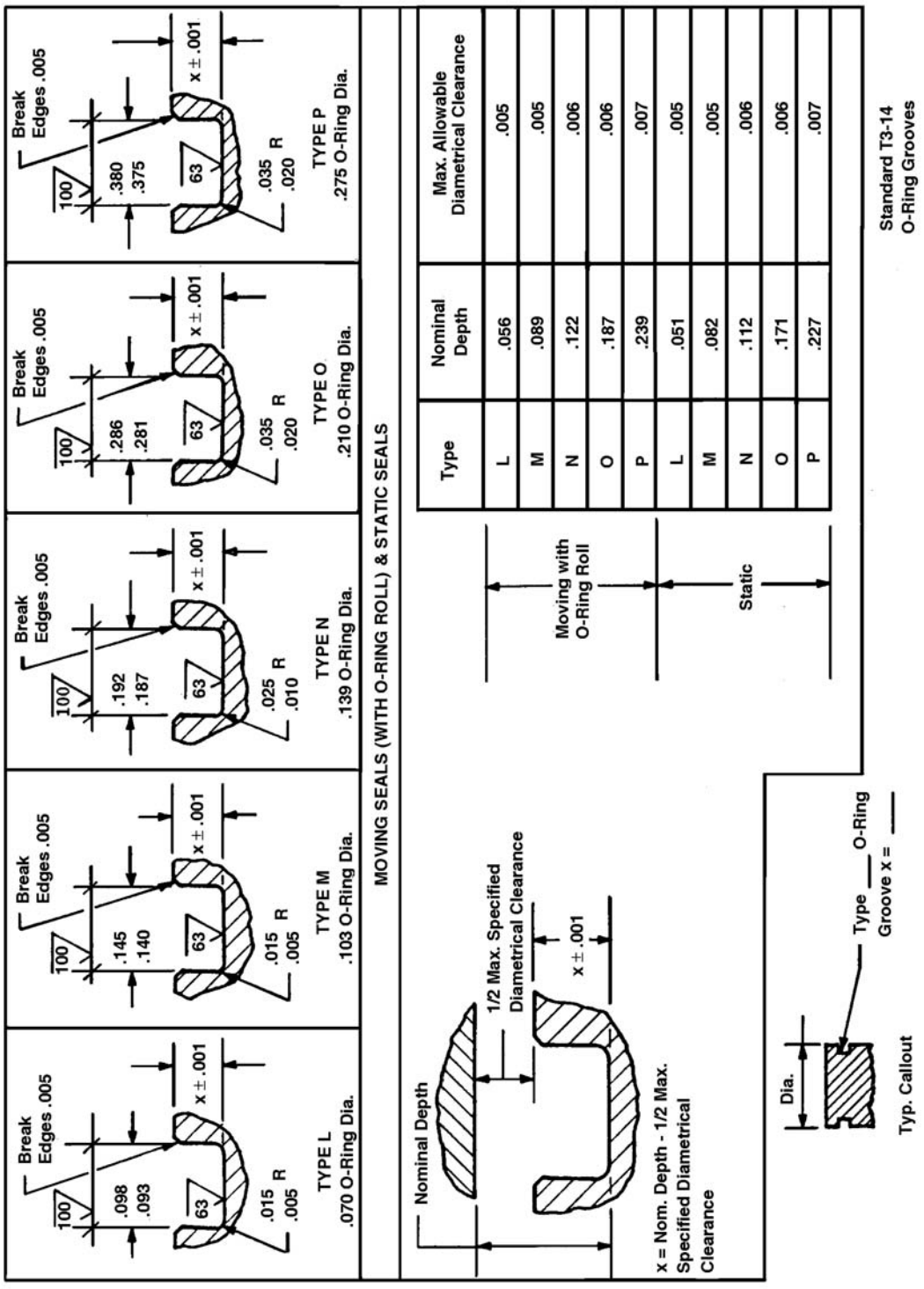
The designer must first determine the classification (flange, vacuum, etc.) and size (cross-sectional diameter) of seal desired. In accordance with the examples on the following pages, designate by callout on the drawing the type (A, B, C, etc.) groove design pre-established by this standard.

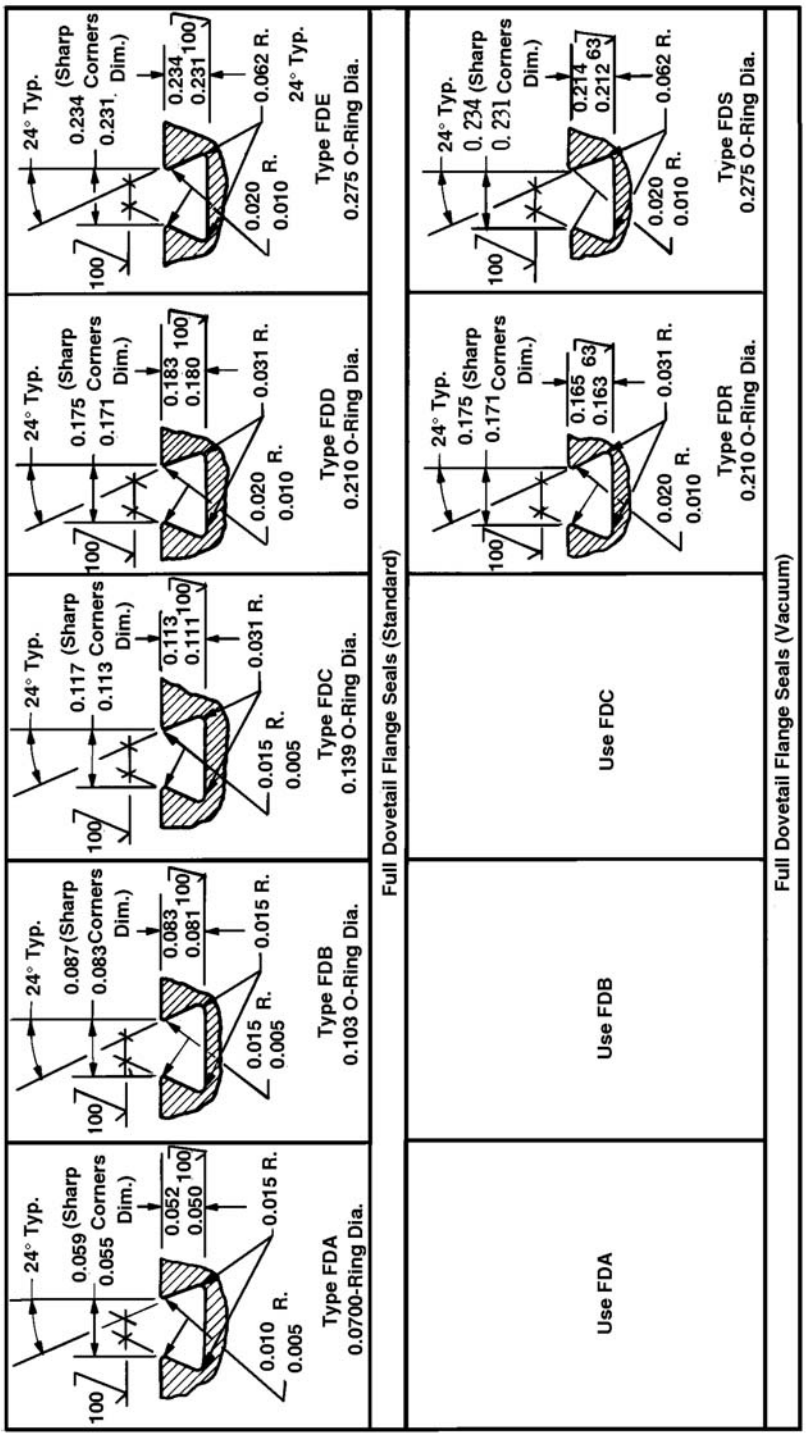

Break Edges .005
100
.107
.101
.054
.050
.015 R.
.005
TYPE A
.070 O-Ring Dia.
Break Edges .005
100
.142
.136
.080
.074
.015 R.
.005
TYPE B
.103 O-Ring Dia.
Break Edges .005
100
.187
.177
.107
.101
.025 R.
.010
TYPE C
.139 O-Ring Dia.
Break Edges .005
100
.290
.270
.162
.152
.035 R.
.020
TYPE D
.210 O-Ring Dia.
Break Edges .005
100
.362
.342
.211
.201
.035 R.
.020
TYPE E
.275 O-Ring Dia.
FLANGE SEALS (STANDARD)
Break Edges .005
100
.088
.082
63
.054
.050
.015 R.
.005
TYPE R
.070 O-Ring Dia.
Break Edges .005
100
.123
.117
63
.080
.074
.015 R.
.005
TYPE S
.103 O-Ring Dia.
Break Edges .005
100
.163
.157
63
.107
.101
.025 R.
.010
TYPE T
.139 O-Ring Dia.
Break Edges .005
100
.253
.247
63
.162
.152
.035 R.
.020
TYPE U
.210 O-Ring Dia.
Break Edges .005
100
.328
.322
63
.211
.201
.035 R.
.020
TYPE V
.275 O-Ring Dia.
FLANGE SEALS (VACUUM)
Dia.
Type Groove
O-Ring
Typ. Callout
Standard T3-14
O-Ring Grooves



Type	Nominal Depth	Max. Allowable Diametrical Clearance
F	.056	.005
G	.089	.005
H	.122	.006
J	.187	.006
K	.239	.007

Standard T3-14
O-Ring Grooves


Break Edges .005
100
.098
.093
63
x ± .001
.015
.005 R
TYPE L
.070 O-Ring Dia.
Break Edges .005
100
.145
.140
63
x ± .001
.015
.005 R
TYPE M
.103 O-Ring Dia.
Break Edges .005
100
.192
.187
63
x ± .001
.025
.010 R
TYPE N
.139 O-Ring Dia.
Break Edges .005
100
.286
.281
63
x ± .001
.035
.020 R
TYPE O
.210 O-Ring Dia.
Break Edges .005
100
.380
.375
63
x ± .001
.035
.020 R
TYPE P
.275 O-Ring Dia.
MOVING SEALS (WITH O-RING ROLL) & STATIC SEALS
Nominal Depth
1/2 Max. Specified Diametrical Clearance
x ± .001
x = Nom. Depth - 1/2 Max. Specified Diametrical Clearance
Dia.
Type ___ O-Ring
Groove x = ___
Typ. Callout
Moving with O-Ring Roll
Static
Type
Nominal Depth
Max. Allowable Diametrical Clearance
L .056 .005
M .089 .005
N .122 .006
O .187 .006
P .239 .007
L .051 .005
M .082 .005
N .112 .006
O .171 .006
P .227 .007
Standard T3-14
O-Ring Grooves



AEDC Standard T3-14
Dovetail O-Ring Grooves

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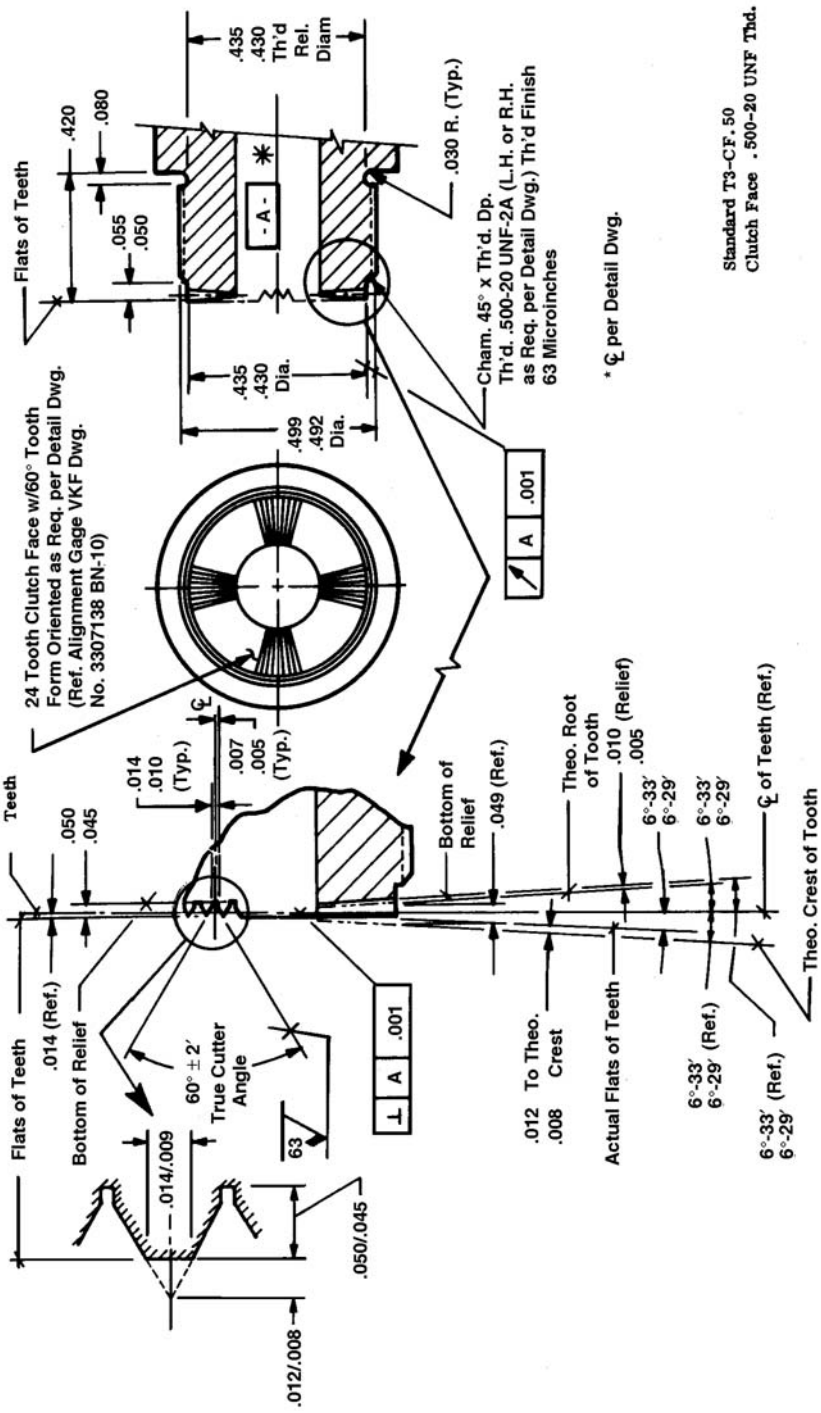
15.0 CLUTCH FACE STANDARD

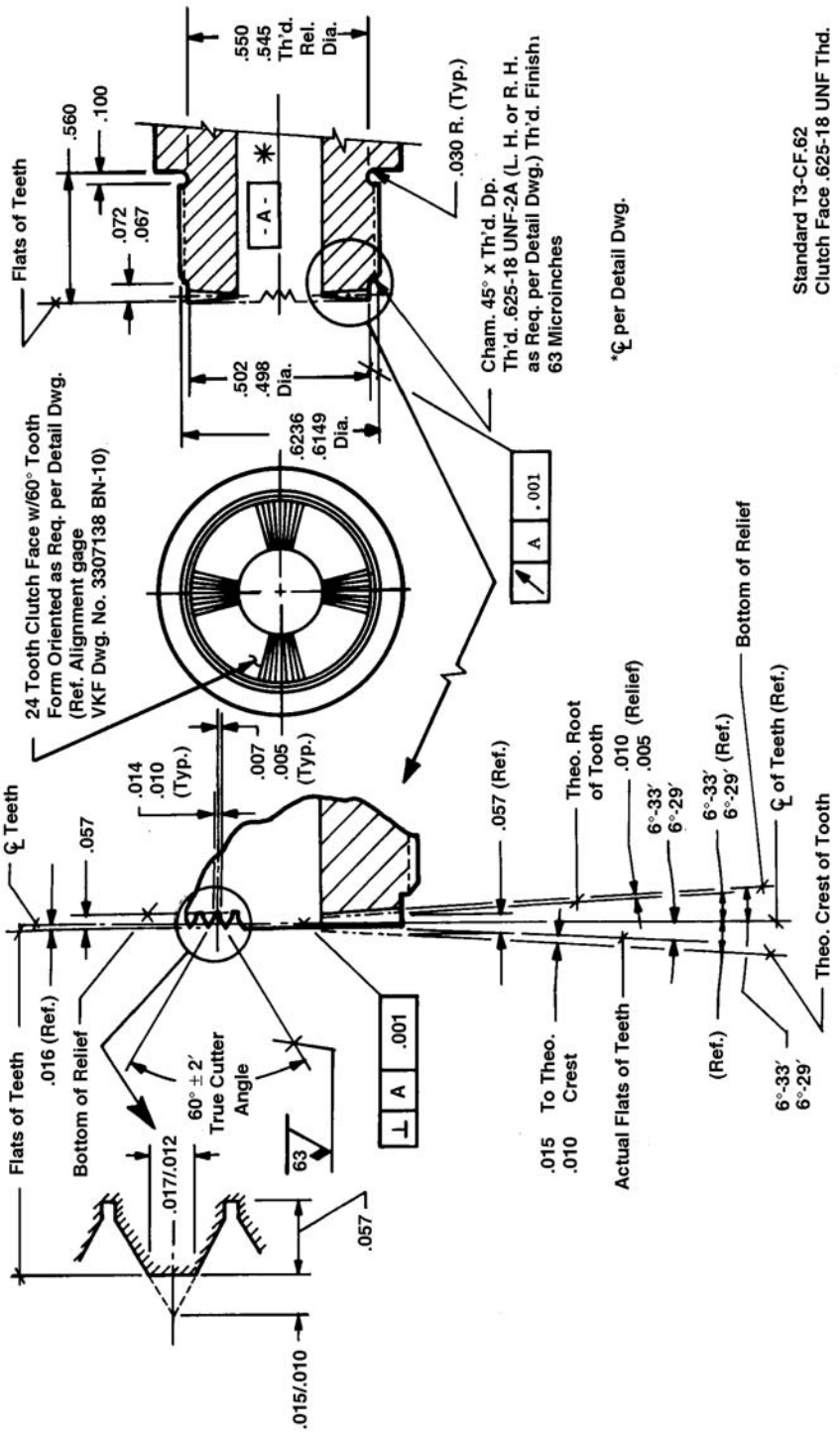
15.1 PURPOSE

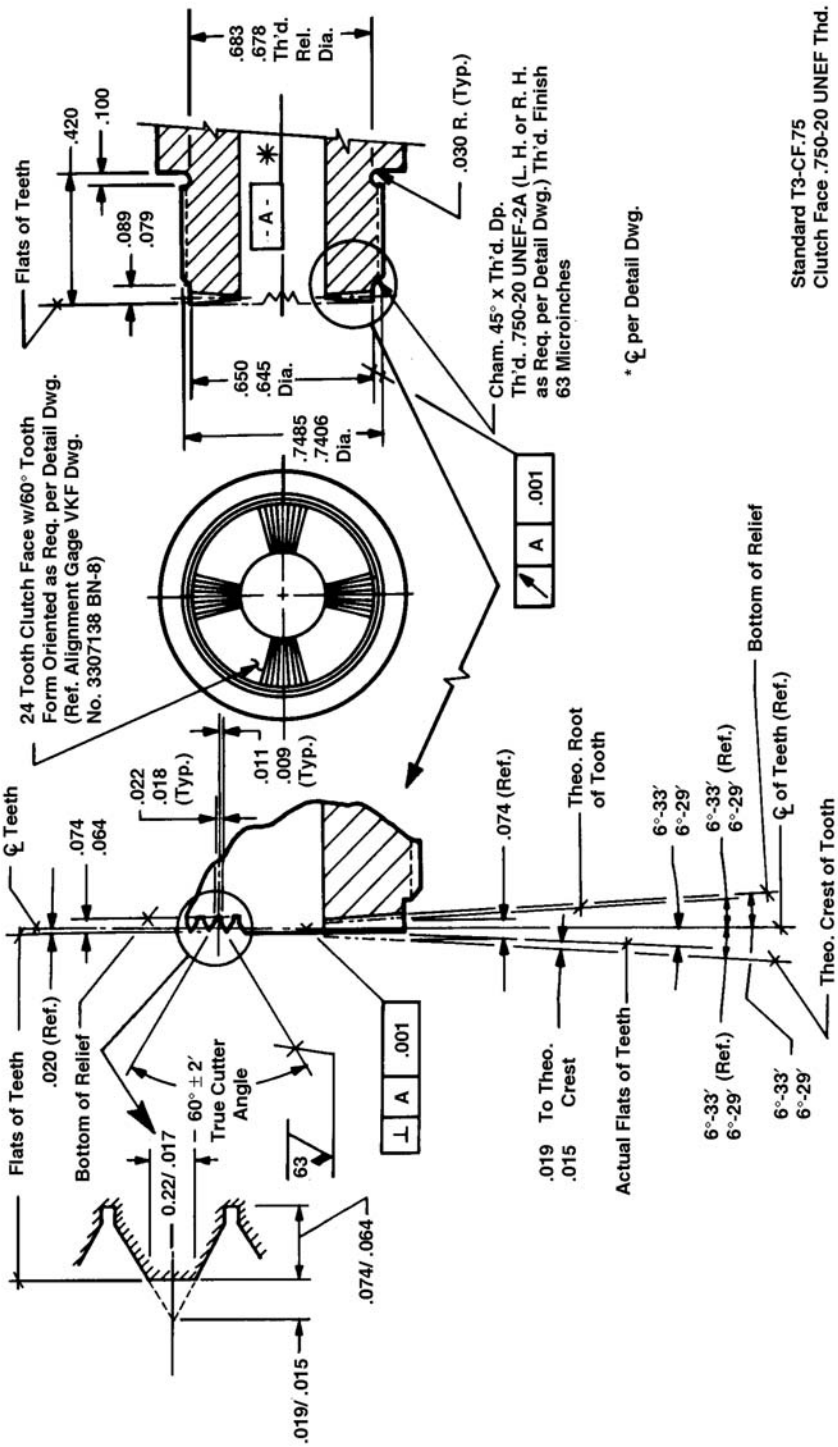
The purpose of this standard is to pre-establish designs for clutch faces in order to save drafting time on mechanical drawings prepared at AEDC.

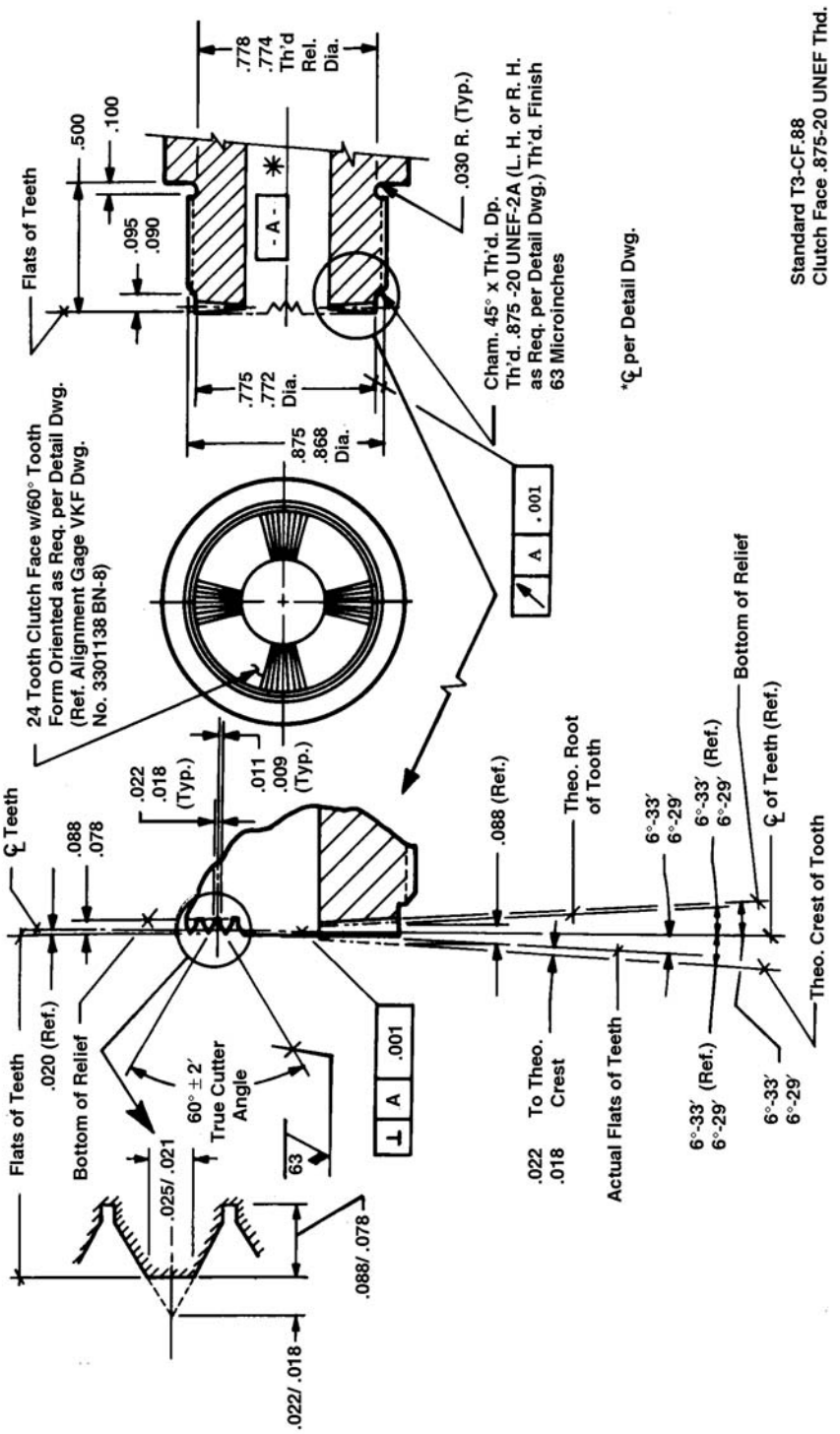
15.2 SCOPE

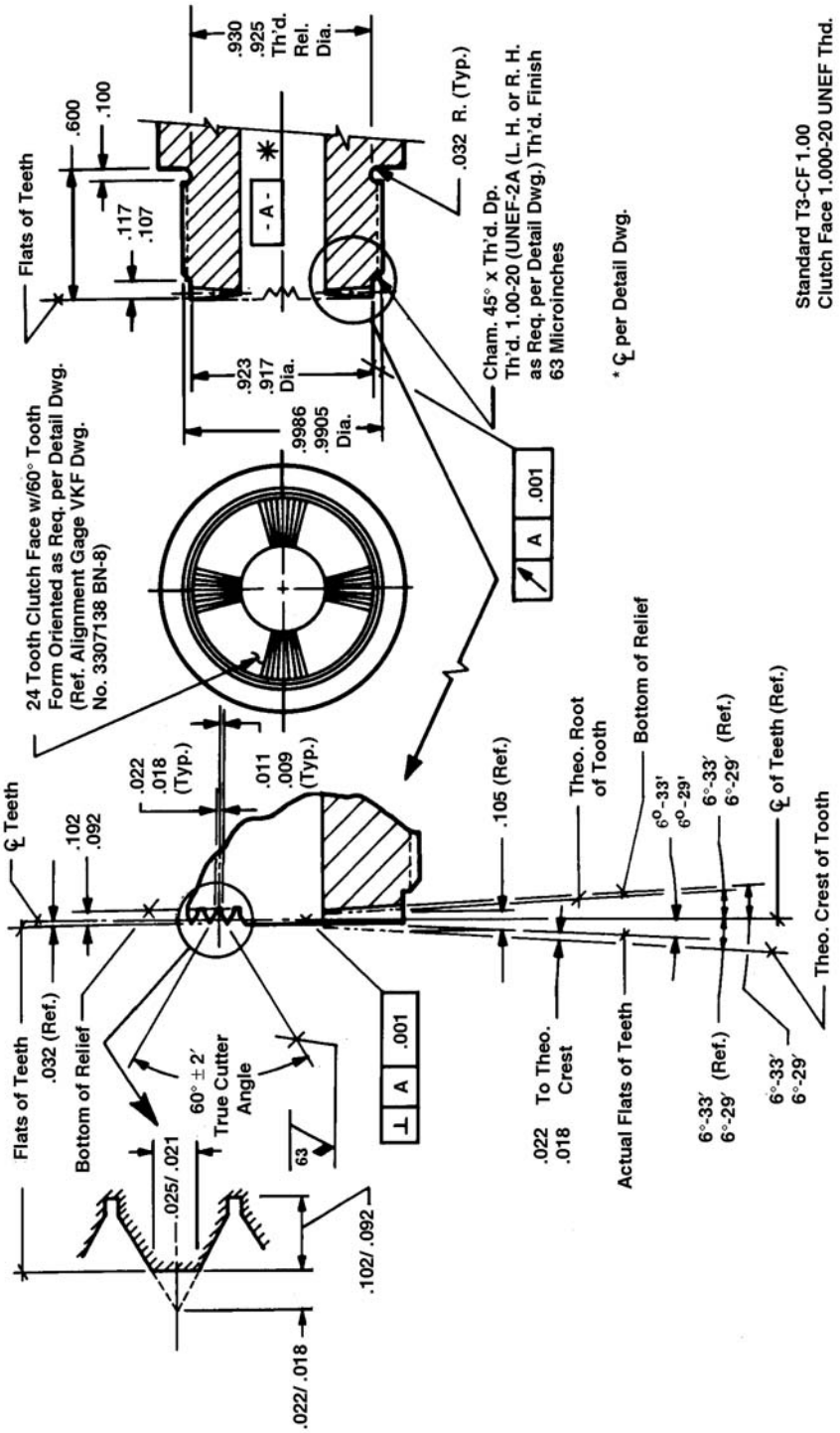
The designer selects the proper size clutch face to satisfy his requirements and calls it out on his drawing by standard number, such as Clutch Face T3-CF.50. The numbers following CF are the diameter in inches of the coupling threads on the clutch face.

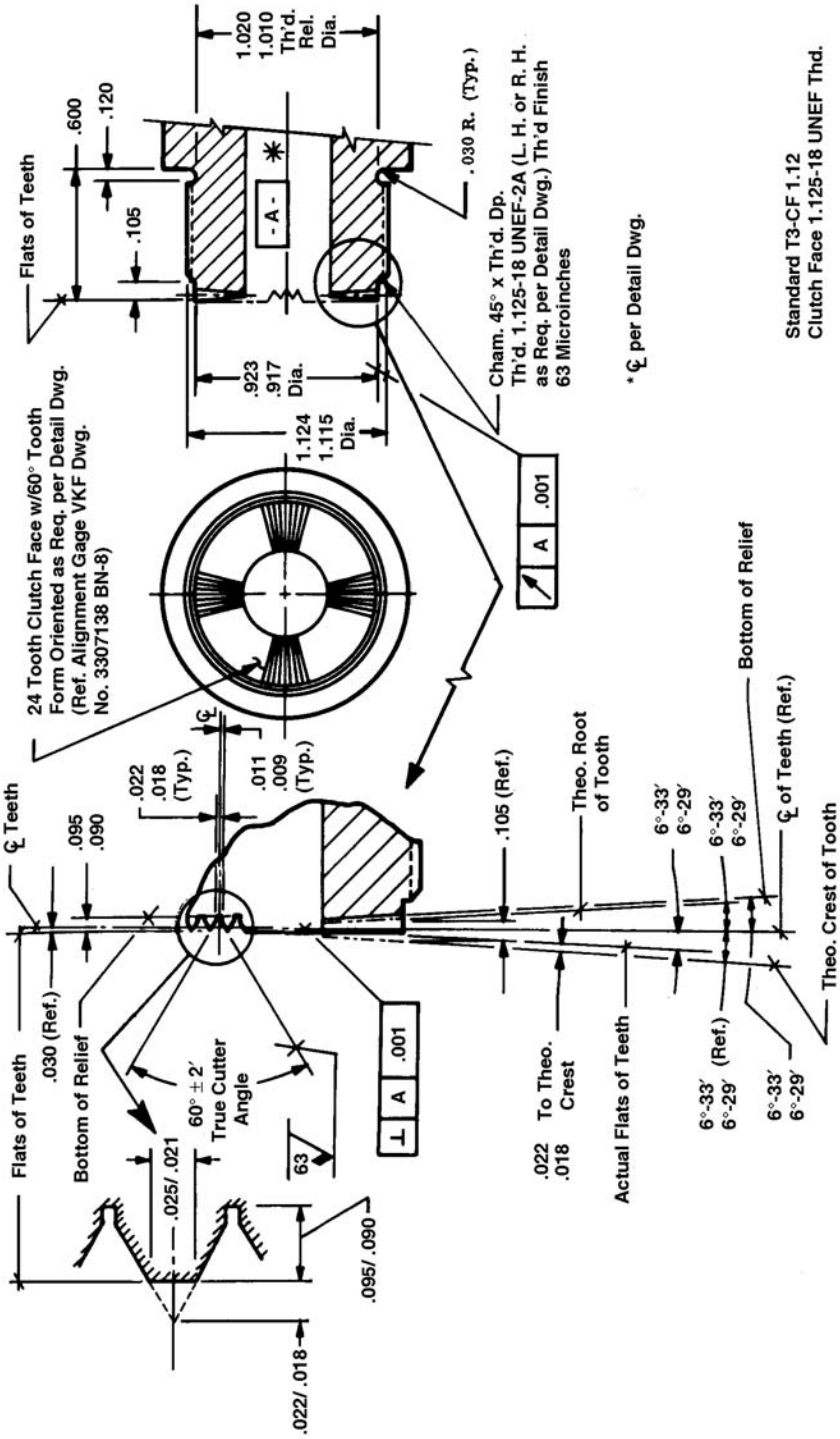

Standard T3-CF. 50
Clutch Face .500-20 UNF Thd.
.435
.430
Th'd
Rel.
Diam
.030 R. (Typ.)
Cham. 45° x Th'd. Dp.
Th'd .500-20 UNF-2A (L.H. or R.H.
as Req. per Detail Dwg.) Th'd Finish
63 Microinches
* ℄ per Detail Dwg.
Flats of Teeth
.420
.080
.055
.050
- A -
.435
.430
Dia.
.499
.492
Dia.
24 Tooth Clutch Face w/60° Tooth
Form Oriented as Req. per Detail Dwg.
(Ref. Alignment Gage VKF Dwg.
No. 3307138 BN-10)
A .001
℄
.014
.010
(Typ.)
.007
.005
(Typ.)
Teeth
.050
.045
Bottom of
Relief
.049 (Ref.)
Theo. Root
of Tooth
.010 (Relief)
.005
6°-33′
6°-29′
6°-33′
6°-29′
℄ of Teeth (Ref.)
Theo. Crest of Tooth
Flats of Teeth
.014 (Ref.)
Bottom of Relief
60° ± 2′
True Cutter
Angle
63
⊥ A .001
.012 To Theo.
.008 Crest
Actual Flats of Teeth
6°-33′
6°-29′ (Ref.)
6°-33′
6°-29′ (Ref.)
.014/.009
.050/.045
.012/.008

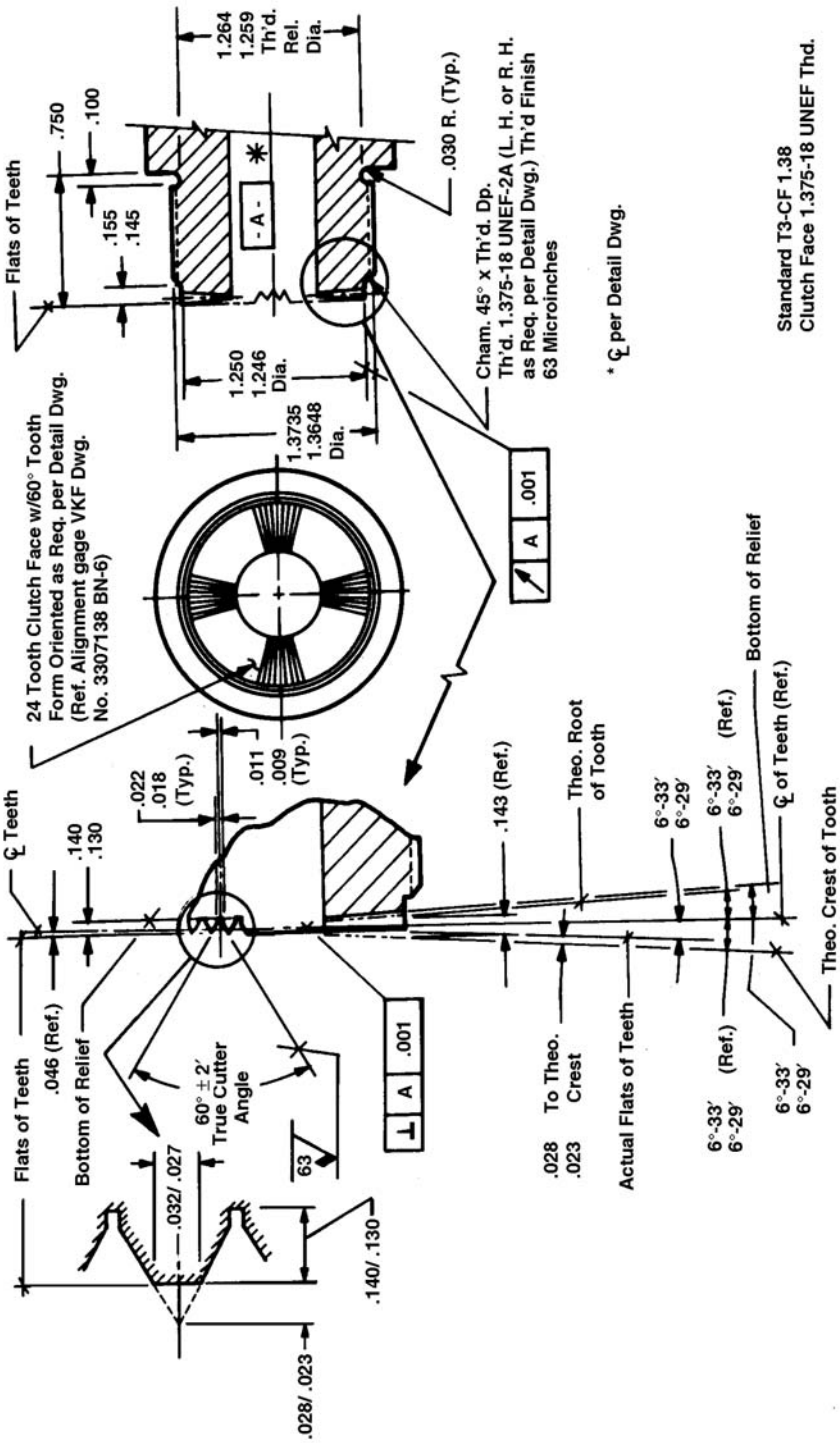

Flats of Teeth
.560
.100
.072
.067
- A -
.550
.545
Th'd.
Rel.
Dia.
.030 R. (Typ.)
.502
.498
Dia.
.6236
.6149
Dia.
Cham. 45° x Th'd. Dp.
Th'd. .625-18 UNF-2A (L. H. or R. H.
as Req. per Detail Dwg.) Th'd. Finish
63 Microinches
*℄ per Detail Dwg.
Standard T3-CF.62
Clutch Face .625-18 UNF Thd.
24 Tooth Clutch Face w/60° Tooth
Form Oriented as Req. per Detail Dwg.
(Ref. Alignment gage
VKF Dwg. No. 3307138 BN-10)
A .001
.014
.010
(Typ.)
.007
.005
(Typ.)
℄ Teeth
.057
.057 (Ref.)
Theo. Root
of Tooth
.010 (Relief)
.005
6°-33′
6°-29′
6°-33′ (Ref.)
6°-29′ (Ref.)
Bottom of Relief
℄ of Teeth (Ref.)
Theo. Crest of Tooth
Flats of Teeth
.016 (Ref.)
Bottom of Relief
60° ± 2′
True Cutter
Angle
63
⊥ A .001
.017/.012
.057
.015/.010
.015
.010
To Theo.
Crest
Actual Flats of Teeth
(Ref.)
6°-33′
6°-29′

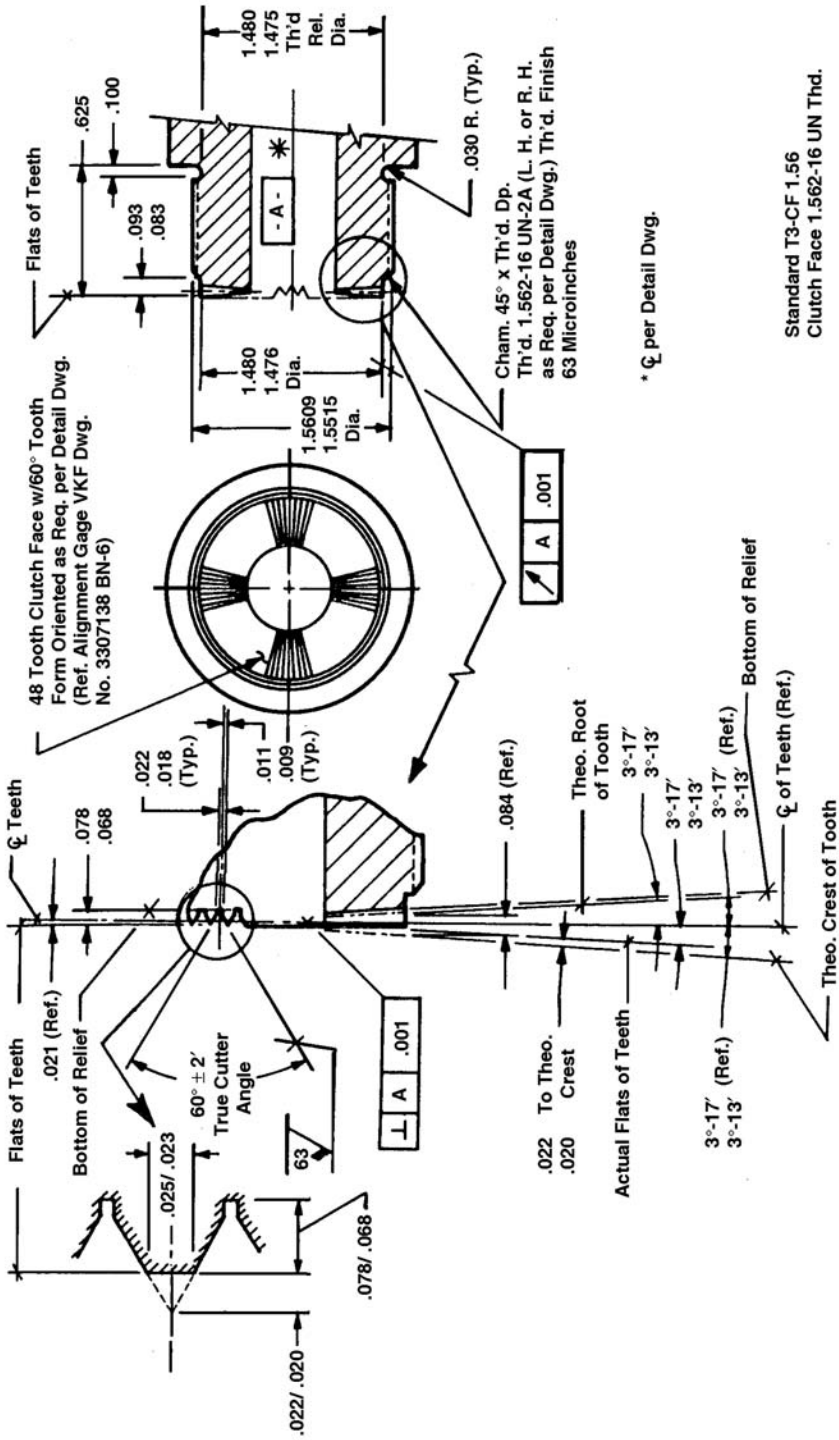

Standard T3-CF.75
Clutch Face .750-20 UNEF Thd.
Flats of Teeth
.420
.100
.089
.079
.683
.678
Th'd.
Rel.
Dia.
.030 R. (Typ.)
- A -
.650
.645
Dia.
.7485
.7406
Dia.
Cham. 45° x Th'd. Dp.
Th'd. .750-20 UNEF-2A (L. H. or R. H.
as Req. per Detail Dwg.) Th'd. Finish
63 Microinches
* ℄ per Detail Dwg.
24 Tooth Clutch Face w/60° Tooth
Form Oriented as Req. per Detail Dwg.
(Ref. Alignment Gage VKF Dwg.
No. 3307138 BN-8)
A .001
℄ Teeth
.074
.064
.022
.018
(Typ.)
.011
.009
(Typ.)
.074 (Ref.)
Theo. Root
of Tooth
6°-33′
6°-29′
6°-33′
6°-29′ (Ref.)
Bottom of Relief
℄ of Teeth (Ref.)
Theo. Crest of Tooth
Flats of Teeth
.020 (Ref.)
Bottom of Relief
60° ±2′
True Cutter
Angle
63
⊥ A .001
.019
.015
To Theo.
Crest
Actual Flats of Teeth
6°-33′
6°-29′ (Ref.)
6°-33′
6°-29′
0.22/ .017
.074/ .064
.019/ .015

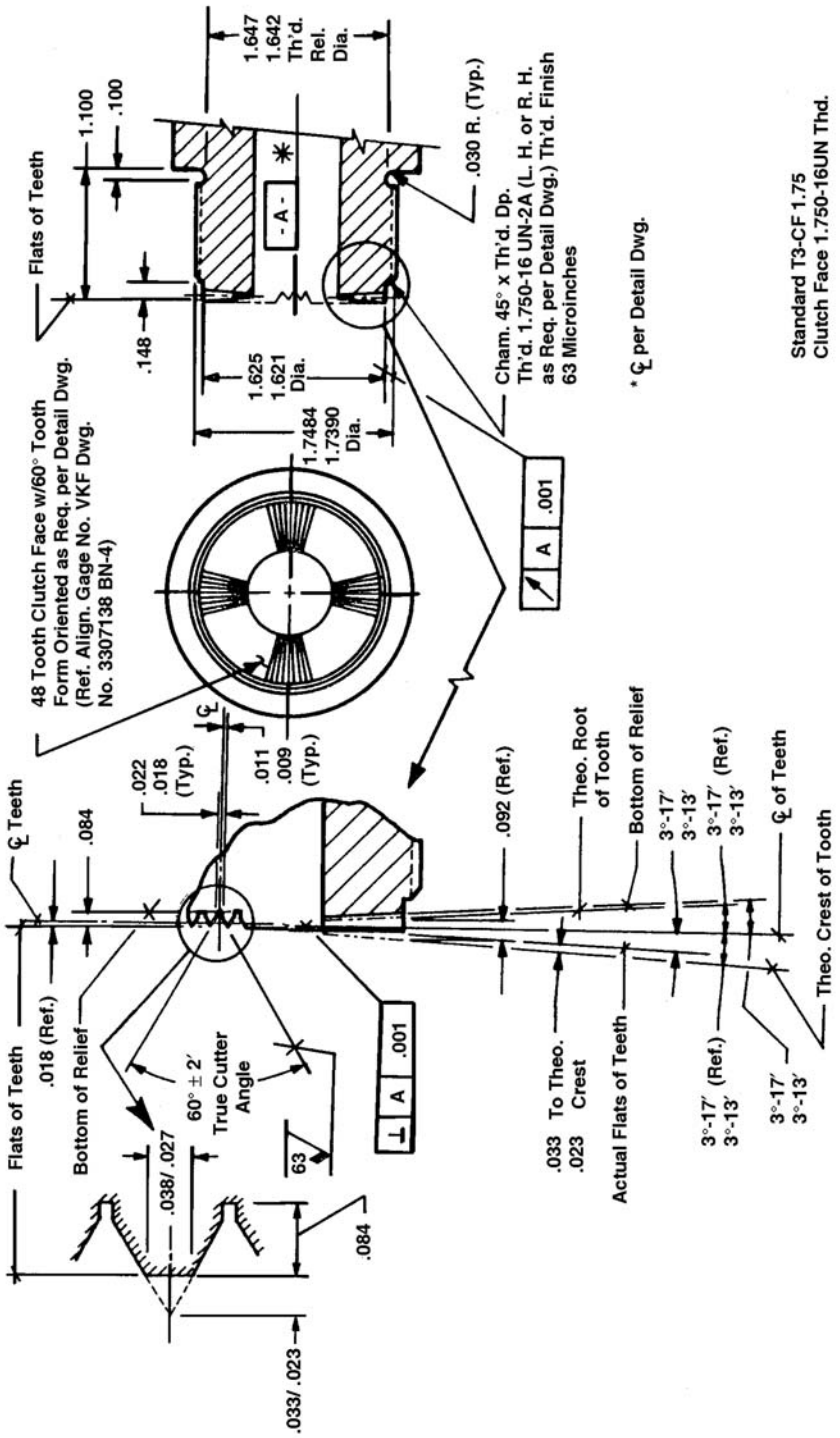

Standard T3-CF.88
Clutch Face .875-20 UNEF Thd.
Flats of Teeth
.500
.100
.095
.090
.778
.774
Th'd
Rel.
Dia.
- A -
.030 R. (Typ.)
Cham. 45° x Th'd. Dp.
Th'd. .875 -20 UNEF-2A (L. H. or R. H.
as Req. per Detail Dwg.) Th'd. Finish
63 Microinches
*℄ per Detail Dwg.
.775
.772
Dia.
.875
.868
Dia.
24 Tooth Clutch Face w/60° Tooth
Form Oriented as Req. per Detail Dwg.
(Ref. Alignment Gage VKF Dwg.
No. 3301138 BN-8)
A .001
.022
.018
(Typ.)
.011
.009
(Typ.)
℄ Teeth
.088
.078
.088 (Ref.)
Theo. Root
of Tooth
6°-33′
6°-29′
6°-33′ (Ref.)
6°-29′ (Ref.)
Bottom of Relief
℄ of Teeth (Ref.)
Theo. Crest of Tooth
Flats of Teeth
.020 (Ref.)
Bottom of Relief
60° ± 2′
True Cutter
Angle
63
⊥ A .001
.025/ .021
.088/ .078
.022/ .018
.022
.018
To Theo.
Crest
Actual Flats of Teeth
6°-33′
6°-29′ (Ref.)
6°-33′
6°-29′

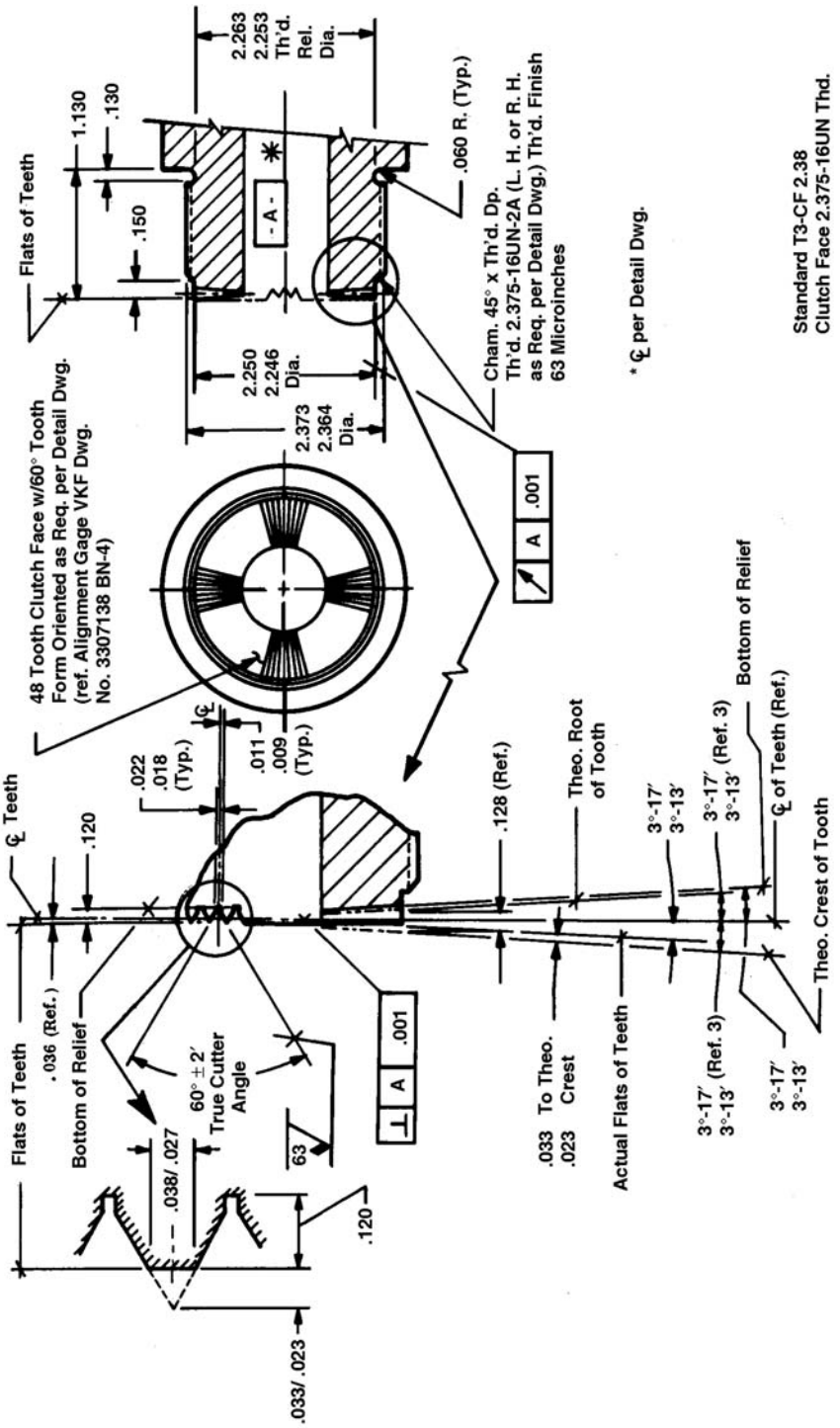

Standard T3-CF 1.00
Clutch Face 1.000-20 UNEF Thd.
.930
.925
Th'd.
Rel.
Dia.
.600
.100
Flats of Teeth
.117
.107
- A -
.032 R. (Typ.)
Cham. 45° x Th'd. Dp.
Th'd. 1.00-20 (UNEF-2A (L. H. or R. H.
as Req. per Detail Dwg.) Th'd. Finish
63 Microinches
* ℄ per Detail Dwg.
.923
.917
Dia.
.9986
.9905
Dia.
24 Tooth Clutch Face w/60° Tooth
Form Oriented as Req. per Detail Dwg.
(Ref. Alignment Gage VKF Dwg.
No. 3307138 BN-8)
A .001
.022
.018
(Typ.)
.011
.009
(Typ.)
℄ Teeth
.102
.092
.105 (Ref.)
Theo. Root
of Tooth
Bottom of Relief
6°-33′
6°-29′
6°-33′
6°-29′ (Ref.)
℄ of Teeth (Ref.)
Theo. Crest of Tooth
Flats of Teeth
.032 (Ref.)
Bottom of Relief
60° ±2′
True Cutter
Angle
63
⊥ A .001
.022
.018
To Theo.
Crest
Actual Flats of Teeth
6°-33′
6°-29′ (Ref.)
6°-33′
6°-29′
.025/ .021
.102/ .092
.022/ .018

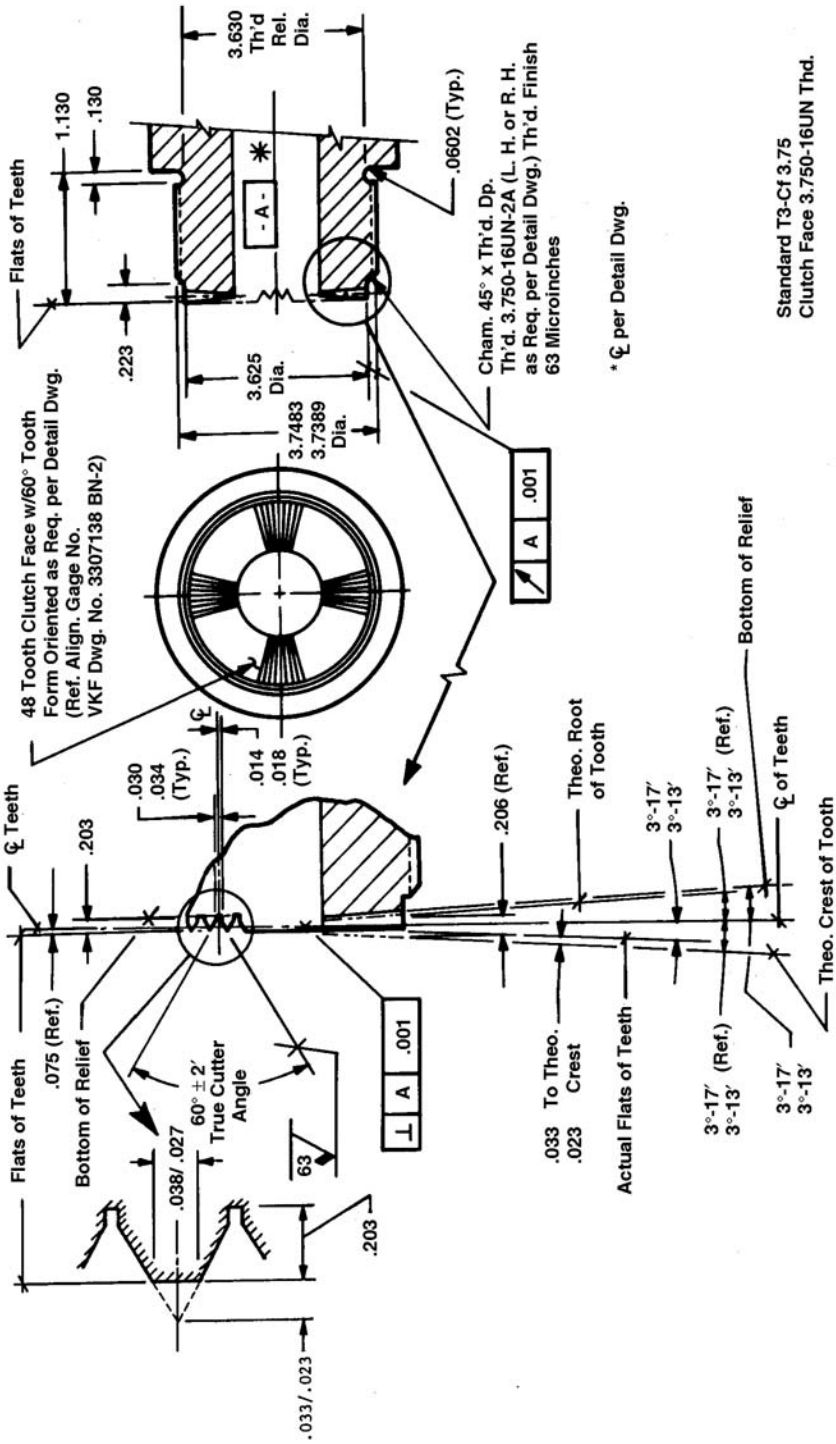

1.020
1.010
Th'd.
Rel.
Dia.
.600
.120
.105
Flats of Teeth
- A -
.030 R. (Typ.)
.923
.917
Dia.
1.124
1.115
Dia.
Cham. 45° x Th'd. Dp.
Th'd. 1.125-18 UNEF-2A (L. H. or R. H.
as Req. per Detail Dwg.) Th'd Finish
63 Microinches
* ℄ per Detail Dwg.
Standard T3-CF 1.12
Clutch Face 1.125-18 UNEF Thd.
24 Tooth Clutch Face w/60° Tooth
Form Oriented as Req. per Detail Dwg.
(Ref. Alignment Gage VKF Dwg.
No. 3307138 BN-8)
⊥ A .001
℄ Teeth
.095
.090
.022
.018
(Typ.)
.011
.009
(Typ.)
.105 (Ref.)
Theo. Root
of Tooth
Bottom of Relief
℄ of Teeth (Ref.)
Theo. Crest of Tooth
6°-33′
6°-29′
Flats of Teeth
.030 (Ref.)
Bottom of Relief
60° ±2′
True Cutter
Angle
63
.025/ .021
.095/ .090
.022/ .018
To Theo.
Crest
Actual Flats of Teeth

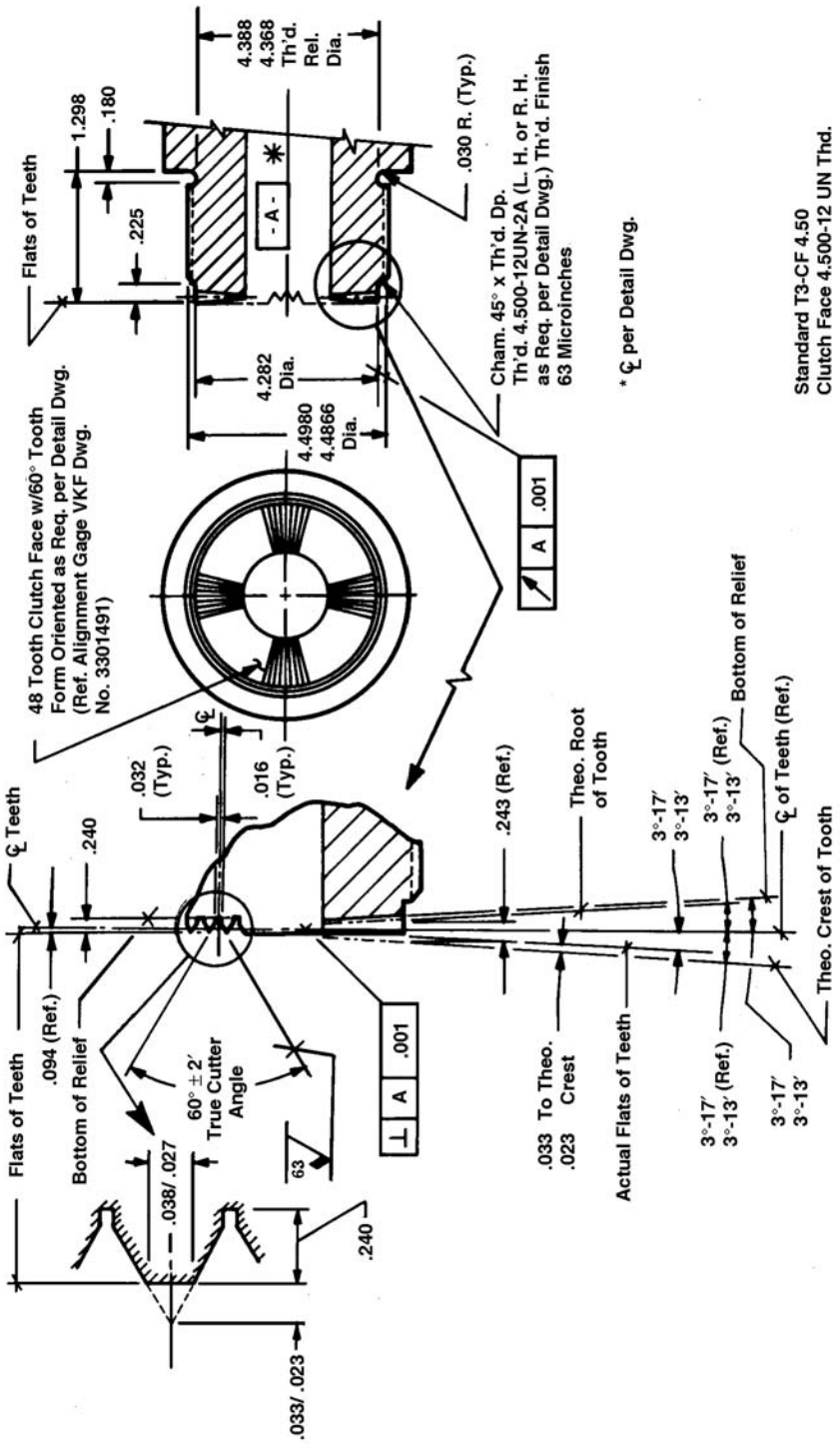

Flats of Teeth
.750
.100
.155
.145
- A -
1.264
1.259
Th'd.
Rel.
Dia.
.030 R. (Typ.)
1.250
1.246
Dia.
1.3735
1.3648
Dia.
Cham. 45° x Th'd. Dp.
Th'd. 1.375-18 UNEF-2A (L. H. or R. H.
as Req. per Detail Dwg.) Th'd Finish
63 Microinches
* ℄ per Detail Dwg.
Standard T3-CF 1.38
Clutch Face 1.375-18 UNEF Thd.
24 Tooth Clutch Face w/60° Tooth
Form Oriented as Req. per Detail Dwg.
(Ref. Alignment gage VKF Dwg.
No. 3307138 BN-6)
A .001
.022
.018
(Typ.)
.011
.009
(Typ.)
℄ Teeth
.140
.130
.143 (Ref.)
Theo. Root
of Tooth
6°-33′
6°-29′
6°-33′
6°-29′
(Ref.)
Bottom of Relief
℄ of Teeth (Ref.)
Theo. Crest of Tooth
Flats of Teeth
.046 (Ref.)
Bottom of Relief
60° ± 2′
True Cutter
Angle
63
⊥ A .001
.032/ .027
.140/ .130
.028/ .023
.028
.023
To Theo.
Crest
Actual Flats of Teeth
6°-33′
6°-29′
(Ref.)
6°-33′
6°-29′

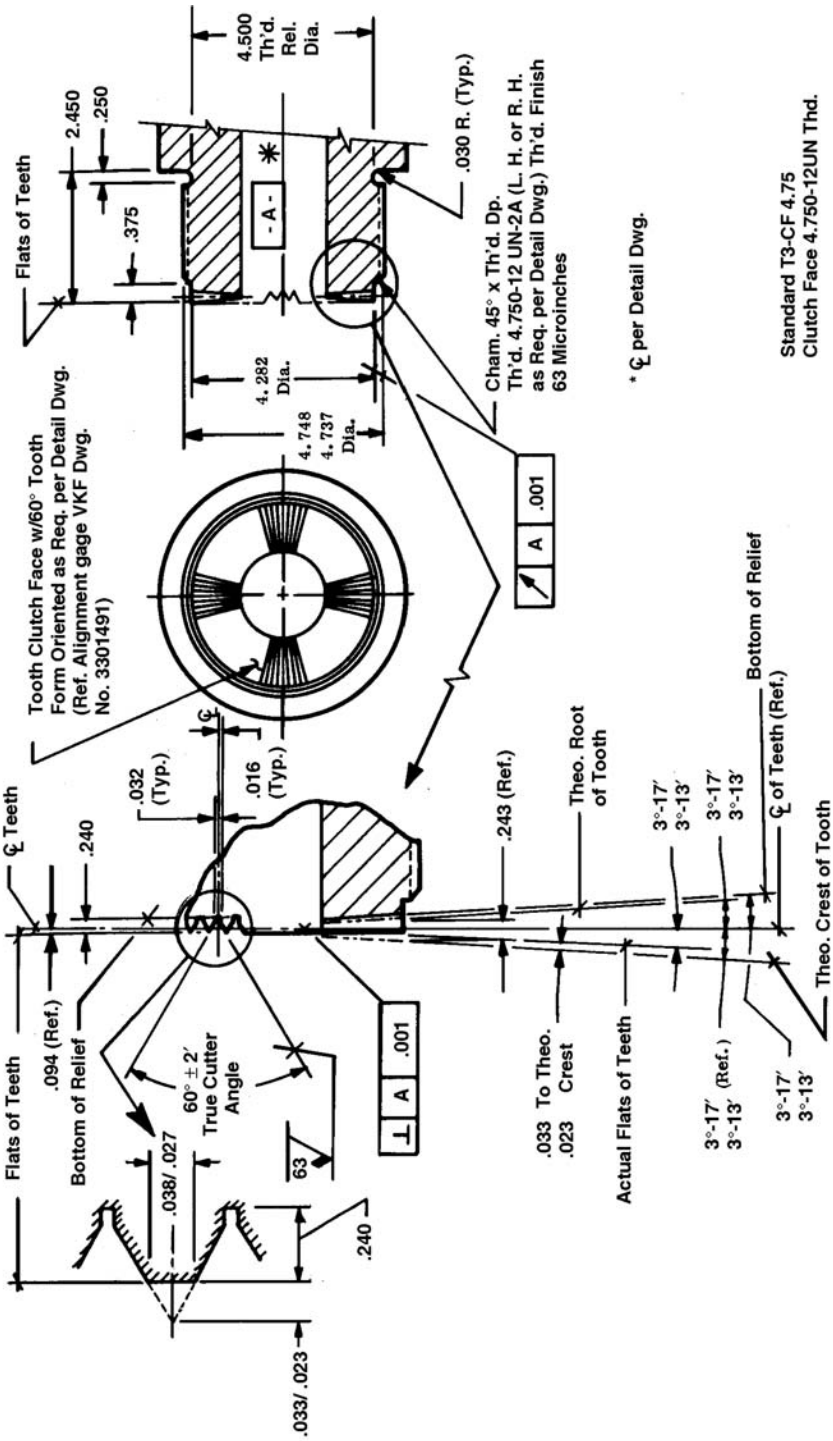

1.480
1.475
Th'd
Rel.
Dia.
.625
.100
Flats of Teeth
.093
.083
- A -
.030 R. (Typ.)
1.480
1.476
Dia.
1.5609
1.5515
Dia.
Cham. 45° x Th'd. Dp.
Th'd. 1.562-16 UN-2A (L. H. or R. H.
as Req. per Detail Dwg.) Th'd. Finish
63 Microinches
* ℄ per Detail Dwg.
Standard T3-CF 1.56
Clutch Face 1.562-16 UN Thd.
48 Tooth Clutch Face w/60° Tooth
Form Oriented as Req. per Detail Dwg.
(Ref. Alignment Gage VKF Dwg.
No. 3307138 BN-6)
A .001
.022
.018
(Typ.)
.011
.009
(Typ.)
℄ Teeth
.078
.068
.084 (Ref.)
Theo. Root
of Tooth
3°-17′
3°-13′
3°-17′
3°-13′
3°-17′ (Ref.)
3°-13′
Bottom of Relief
℄ of Teeth (Ref.)
Theo. Crest of Tooth
Flats of Teeth
.021 (Ref.)
Bottom of Relief
60° ± 2′
True Cutter
Angle
63
⊥ A .001
.025/.023
.078/.068
.022/.020
.022
.020
To Theo.
Crest
Actual Flats of Teeth
3°-17′ (Ref.)
3°-13′

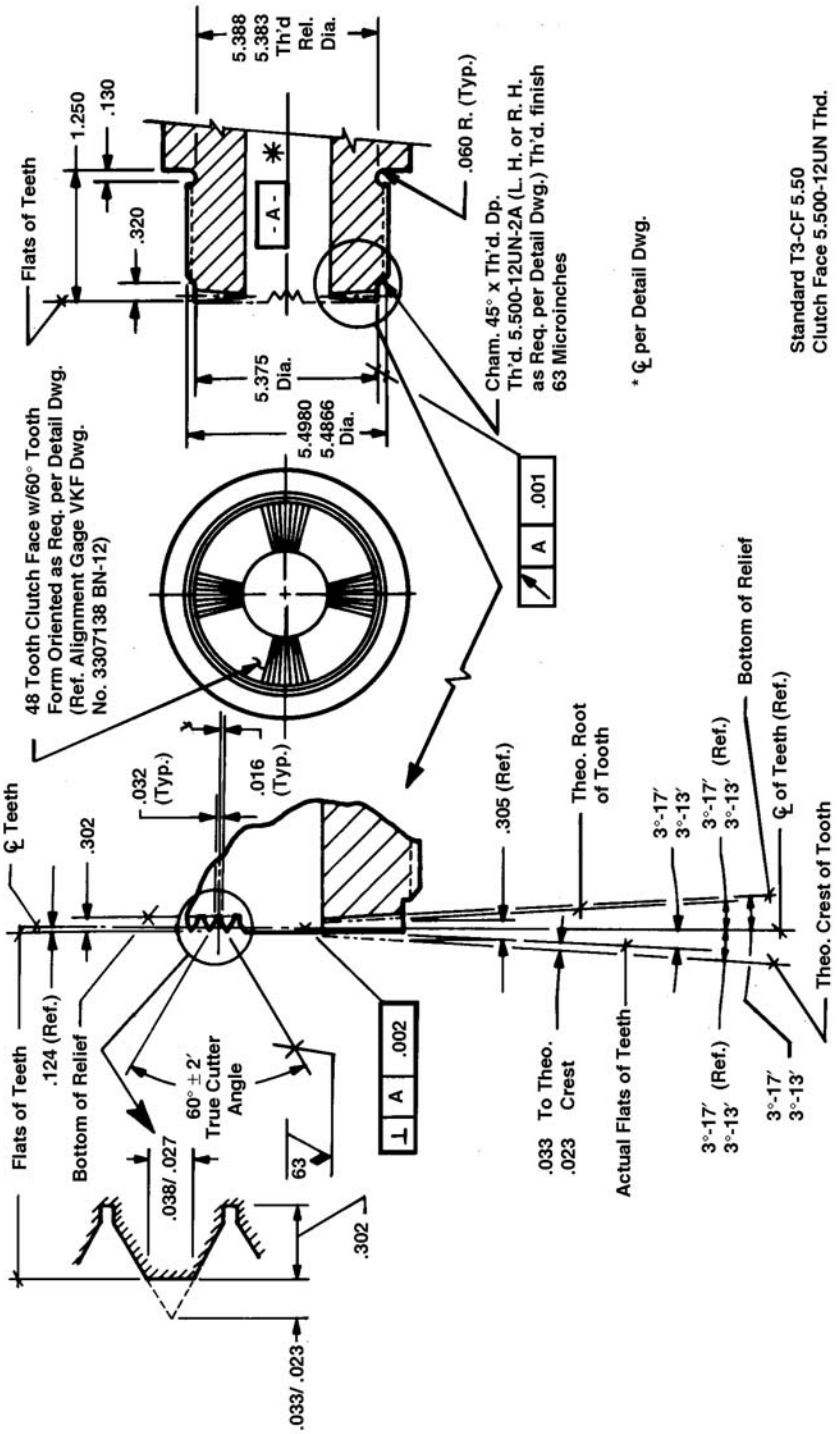

1.647
1.642
Th'd.
Rel.
Dia.
1.100
.100
Flats of Teeth
.030 R. (Typ.)
- A -
.148
1.625
1.621
Dia.
1.7484
1.7390
Dia.
Cham. 45° x Th'd. Dp.
Th'd. 1.750-16 UN-2A (L. H. or R. H.
as Req. per Detail Dwg.) Th'd. Finish
63 Microinches
* ℄ per Detail Dwg.
Standard T3-CF 1.75
Clutch Face 1.750-16UN Thd.
48 Tooth Clutch Face w/60° Tooth
Form Oriented as Req. per Detail Dwg.
(Ref. Align. Gage No. VKF Dwg.
No. 3307138 BN-4)
A .001
℄
.022
.018
(Typ.)
.011
.009
(Typ.)
℄ Teeth
.084
.092 (Ref.)
Theo. Root
of Tooth
Bottom of Relief
3°-17′
3°-13′
3°-17′ (Ref.)
3°-13′
℄ of Teeth
Theo. Crest of Tooth
Flats of Teeth
.018 (Ref.)
Bottom of Relief
60° ± 2′
True Cutter
Angle
63
⊥ A .001
.033
.023
To Theo.
Crest
Actual Flats of Teeth
3°-17′ (Ref.)
3°-13′
3°-17′
3°-13′
.038/ .027
.084
.033/ .023

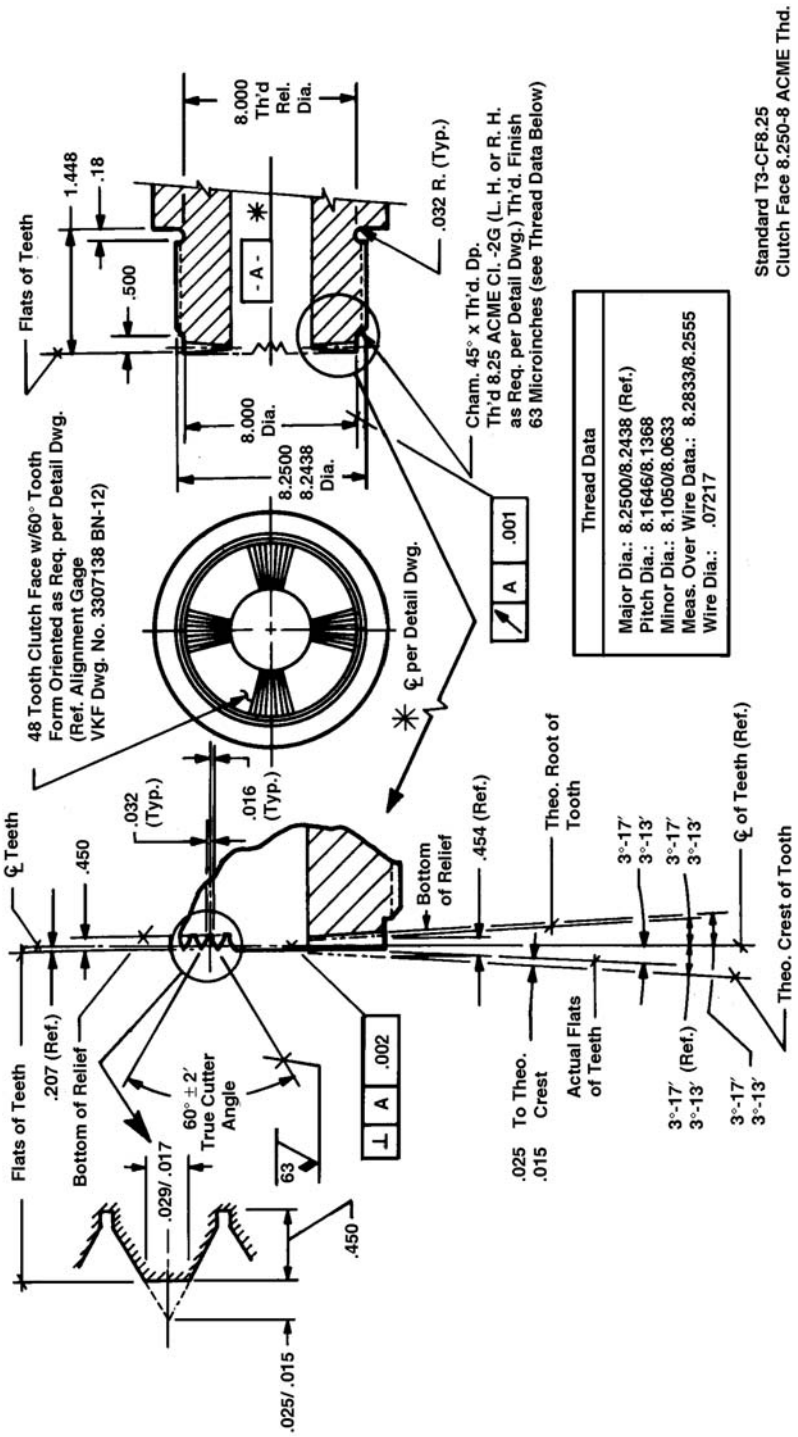

Flats of Teeth
1.130
.130
.150
2.263
2.253
Th'd.
Rel.
Dia.
- A -
.060 R. (Typ.)
2.250
2.246
Dia.
2.373
2.364
Dia.
Cham. 45° x Th'd. Dp.
Th'd. 2.375-16UN-2A (L. H. or R. H.
as Req. per Detail Dwg.) Th'd. Finish
63 Microinches
* ℄ per Detail Dwg.
Standard T3-CF 2.38
Clutch Face 2.375-16UN Thd.
48 Tooth Clutch Face w/60° Tooth
Form Oriented as Req. per Detail Dwg.
(ref. Alignment Gage VKF Dwg.
No. 3307138 BN-4)
A .001
℄ Teeth
.120
.022
.018
(Typ.)
.011
.009
(Typ.)
.128 (Ref.)
Theo. Root
of Tooth
3°-17′
3°-13′
3°-17′ (Ref. 3)
3°-13′
Bottom of Relief
℄ of Teeth (Ref.)
Theo. Crest of Tooth
Flats of Teeth
.036 (Ref.)
Bottom of Relief
60° ± 2′
True Cutter
Angle
63
A .001
.033 To Theo.
.023 Crest
Actual Flats of Teeth
3°-17′ (Ref. 3)
3°-13′
3°-17′
3°-13′
.038/ .027
.120
.033/ .023


3.630
Th'd
Rel.
Dia.
1.130
.130
Flats of Teeth
.0602 (Typ.)
- A -
.223
3.625
Dia.
3.7483
3.7389
Dia.
Cham. 45° x Th'd. Dp.
Th'd. 3.750-16UN-2A (L. H. or R. H.
as Req. per Detail Dwg.) Th'd. Finish
63 Microinches
* ℄ per Detail Dwg.
Standard T3-Cf 3.75
Clutch Face 3.750-16UN Thd.
48 Tooth Clutch Face w/60° Tooth
Form Oriented as Req. per Detail Dwg.
(Ref. Align. Gage No.
VKF Dwg. No. 3307138 BN-2)
A .001
℄
.030
.034
(Typ.)
.014
.018
(Typ.)
℄ Teeth
.203
.206 (Ref.)
Theo. Root
of Tooth
3°-17′
3°-13′
3°-17′ (Ref.)
3°-13′
Bottom of Relief
℄ of Teeth
Theo. Crest of Tooth
Flats of Teeth
.075 (Ref.)
Bottom of Relief
.038/ .027
60° ±2′
True Cutter
Angle
63
⊥ A .001
.033 To Theo.
.023 Crest
Actual Flats of Teeth
3°-17′ (Ref.)
3°-13′
3°-17′
3°-13′
.203
.033/.023


Flats of Teeth
1.298
.180
.225
4.388
4.368
Th'd.
Rel.
Dia.
- A -
.030 R. (Typ.)
4.282
Dia.
4.4980
4.4866
Dia.
Cham. 45° x Th'd. Dp.
Th'd. 4.500-12UN-2A (L. H. or R. H.
as Req. per Detail Dwg.) Th'd. Finish
63 Microinches
* ℄ per Detail Dwg.
Standard T3-CF 4.50
Clutch Face 4.500-12 UN Thd.
48 Tooth Clutch Face w/60° Tooth
Form Oriented as Req. per Detail Dwg.
(Ref. Alignment Gage VKF Dwg.
No. 3301491)
A .001
℄
.032
(Typ.)
.016
(Typ.)
℄ Teeth
.240
Flats of Teeth
.094 (Ref.)
Bottom of Relief
.038/ .027
60° ± 2′
True Cutter
Angle
63
.240
.033/ .023
⊥ A .001
.243 (Ref.)
Theo. Root
of Tooth
.033 To Theo.
.023 Crest
Actual Flats of Teeth
3°-17′
3°-13′
3°-17′ (Ref.)
3°-13′
Bottom of Relief
℄ of Teeth (Ref.)
Theo. Crest of Tooth


4.500 Th'd. Rel. Dia.
2.450
.250
.375
Flats of Teeth
- A -
.030 R. (Typ.)
4.282 Dia.
4.748
4.737 Dia.
Cham. 45° x Th'd. Dp. Th'd. 4.750-12 UN-2A (L. H. or R. H. as Req. per Detail Dwg.) Th'd. Finish 63 Microinches
* ℄ per Detail Dwg.
Standard T3-CF 4.75 Clutch Face 4.750-12UN Thd.
Tooth Clutch Face w/60° Tooth Form Oriented as Req. per Detail Dwg. (Ref. Alignment gage VKF Dwg. No. 3301491)
A .001
℄ Teeth
.032 (Typ.)
.016 (Typ.)
.240
.243 (Ref.)
Theo. Root of Tooth
3°-17′ 3°-13′
Bottom of Relief
℄ of Teeth (Ref.)
Theo. Crest of Tooth
Flats of Teeth
.094 (Ref.)
Bottom of Relief
60° ± 2′ True Cutter Angle
63
.038/ .027
.240
.033/ .023
.033 To Theo. Crest
.023
Actual Flats of Teeth
3°-17′ (Ref.) 3°-13′


Flats of Teeth
1.250
.130
.320
5.388
5.383
Th'd
Rel.
Dia.
- A -
.060 R. (Typ.)
Cham. 45° x Th'd. Dp.
Th'd. 5.500-12UN-2A (L. H. or R. H.
as Req. per Detail Dwg.) Th'd. finish
63 Microinches
* ℄ per Detail Dwg.
Standard T3-CF 5.50
Clutch Face 5.500-12UN Thd.
5.375
Dia.
5.4980
5.4866
Dia.
48 Tooth Clutch Face w/60° Tooth
Form Oriented as Req. per Detail Dwg.
(Ref. Alignment Gage VKF Dwg.
No. 3307138 BN-12)
A .001
℄ Teeth
.302
.032
(Typ.)
.016
(Typ.)
.305 (Ref.)
Theo. Root
of Tooth
3°-17′
3°-13′
3°-17′
3°-13′
(Ref.)
Bottom of Relief
℄ of Teeth (Ref.)
Theo. Crest of Tooth
Flats of Teeth
.124 (Ref.)
Bottom of Relief
60° ± 2′
True Cutter
Angle
63
⊥ A .002
.033
.023
To Theo.
Crest
Actual Flats of Teeth
3°-17′
3°-13′
(Ref.)
3°-17′
3°-13′
.038/ .027
.033/ .023
.302


Standard T3-CF8.25
Clutch Face 8.250-8 ACME Thd.
Thread Data
Major Dia.: 8.2500/8.2438 (Ref.)
Pitch Dia.: 8.1646/8.1368
Minor Dia.: 8.1050/8.0633
Meas. Over Wire Data.: 8.2833/8.2555
Wire Dia.: .07217
8.000 Th'd Rel. Dia.
1.448
.18
.500
Flats of Teeth
- A -
8.000 Dia.
8.2500
8.2438 Dia.
.032 R. (Typ.)
Cham. 45° x Th'd. Dp.
Th'd 8.25 ACME Cl. -2G (L. H. or R. H.
as Req. per Detail Dwg.) Th'd. Finish
63 Microinches (see Thread Data Below)
48 Tooth Clutch Face w/60° Tooth
Form Oriented as Req. per Detail Dwg.
(Ref. Alignment Gage
VKF Dwg. No. 3307138 BN-12)
℄ per Detail Dwg.
A .001
.032 (Typ.)
.016 (Typ.)
℄ Teeth
.450
Bottom of Relief
.454 (Ref.)
Theo. Root of Tooth
3°-17′
3°-13′
℄ of Teeth (Ref.)
Theo. Crest of Tooth
Flats of Teeth
.207 (Ref.)
Bottom of Relief
.029/ .017
60° ± 2′
True Cutter
Angle
63
⊥ A .002
.025
.015
To Theo.
Crest
Actual Flats
of Teeth
.450
.025/ .015

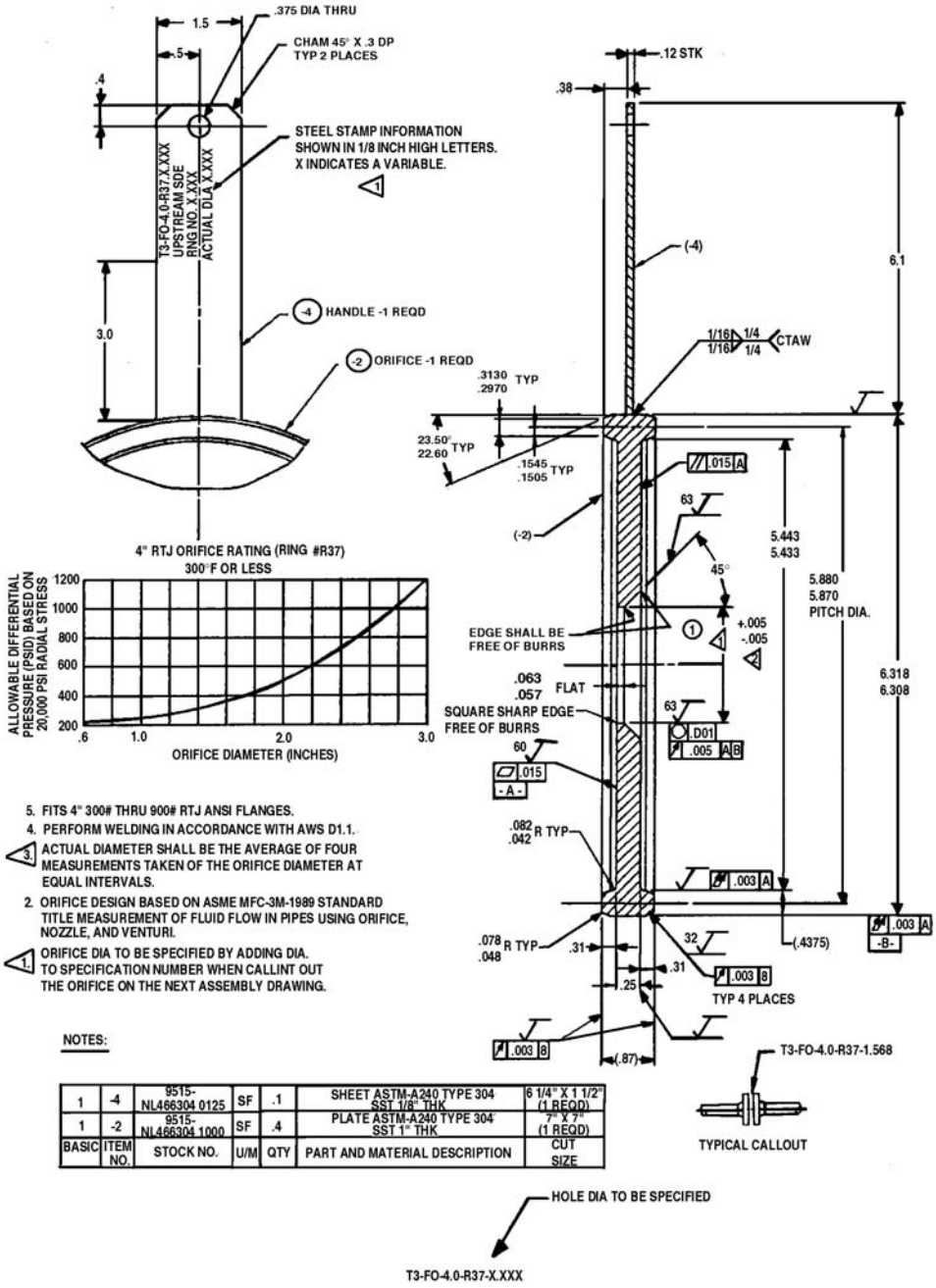
16.0 STANDARD DESIGN DETAILS

16.1 PURPOSE

The purpose of this standard is to provide standard design details for parts frequently detailed on drawings, thus avoiding redraw or reissue of drawings for each shop release.

16.2 SCOPE

Design details defined in this standard can be referenced on a drawing by defining location and identifying the detail number, complete with any optional size information. The shop will refer to Engineering Standard T-3 for the actual details required for fabrication.



BASIC	ITEM NO.	STOCK NO.	U/M	QTY	PART AND MATERIAL DESCRIPTION	CUT SIZE
1	-4	9515-NL466304 0125	SF	.1	SHEET ASTM-A240 TYPE 304 SST 1/8" THK	6 1/4" X 1 1/2" (1 REQD)
1	-2	9515-NL466304 1000	SF	.4	PLATE ASTM-A240 TYPE 304 SST 1" THK	7" X 7" (1 REQD)

Figure 16-1. AEDC Standard T#-FO Flow Orifice

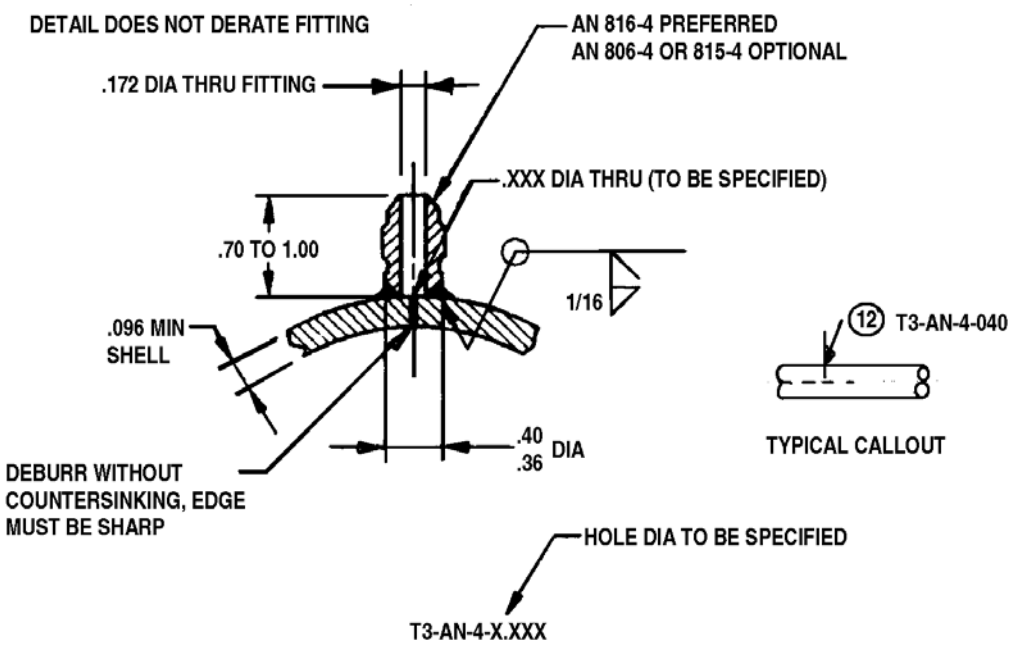


Figure 16-2. AEDC Standard T3-AN Modified AN Fitting Branch Connection

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17.0 **IDENTIFICATION OF HAZARDOUS MATERIALS**

The Occupational Safety and Health Act, Section 6(b)(7), requires that employees be made aware of hazards to which they are exposed.

Any AEDC onsite effort involving materials which are or which contain toxic/hazardous materials will be accompanied by a drawing bearing the following information in the field of the drawing adjacent to part/area of concern:

CAUTION: Contains. (List material common name)
Special Processing Instruction Required
Reference AEDC Safety Manual Section E.

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18.0 IDENTIFICATION OF ITEMS FOR CERTIFICATION

18.1 PURPOSE

All dimensions, materials/equipment, and processes specified on drawings are necessary to completely define the designed part, assembly, or installation; however, certain designs may be designated for applications which directly affect personnel safety, major equipment, or test results. When such applications arise, certain dimensions, materials/equipment, and processes may be judged by the designer to require written quality certification.

18.2 IDENTIFICATION OF ITEMS

These items shall be identified by:

1. Placing an (I) beside those dimensions requiring certified inspection documentation.

2. Placing an (M) beside each place a material or piece of equipment requiring documentation is called out. Where the item is listed in a Bill of Material, the symbol must also appear in the Remarks Column.

3. Placing a (P) beside the process requiring documentation. If no general note contains the process, place a general note on the drawing directing the reviewer to the location, on the drawing, of the process(es). Place a (P) to the left of this note also.

When item symbols are used on a drawing which will be sent to other than AEDC Contractors for fabrication, an adequate explanation of the symbols and the action to be taken will be supplied to the Contractor.

18.3 GUIDELINES FOR REQUIRING CERTIFICATION

Certification is expensive and should only be specified when the risks justify the additional cost. The following definitions should guide in the selection of those items requiring certification documentation.

Certified Dimensions—(I)—Those dimensions which, if not within specified tolerances, will severely impair the form, fit, or function characteristics of the part or component.

Certified Materials/Equipment—(M)—Materials and procured equipment or parts which have been chosen for an application because of particularly sensitive properties—if it is probable that the inadvertent substitution of apparently similar material or parts will result in injury to personnel, damage to major equipment, or jeopardize test results. These properties may be function, strength, weight, temperature sensitivity, weldability, or any other unique characteristics.

Certified Process—(P) —Processes which have particularly sensitive features, requiring stringent controls to achieve the required characteristics of the item to which it pertains. These may be processes involving welding, heat treatment, plating, or other fabrication processes. Consideration should be given to the material involved in the process; it may need to be labeled for certification.

18.4 REQUIRED DOCUMENTATION

The fabricating contractor shall provide to the originating design organization the following information for each item identified for certification:

(I) Certified as-built dimension (actual dimension shall be recorded – normally recorded beside the original drawing demension using a “redline drawing” format documentation)

(M) Signed certification that the material/equipment specified was incorporated per specifications (include manufacturer’s certifications, receiving inspection report, documentation and sign-off at each step of fabrication/assembly, or other appropriate documentation).

(P) Step by step documentation of process as executed. (actual signed off porcedure used in the manufacturing process is required)

19.0 PART IDENTIFICTION

19.1 REQUIREMENTS

Parts, especially machined and fabricated parts that are used in other assemblies, are frequently required to be permanently marked with a unique identification. The requirement to identify parts will be specified on the drawing. This identification consists of the drawing number and item number (RUT04876.01-4 etc) unless specified otherwise.

19.2 DEVIATIONS FROM DRAWINGS

When a part deviates from the drawing specification, but is determined by the owner to be usable (frequently with restrictions), one of the following options for documentation is required.

a. If all the like parts have the same deviation and future fabrication will be like this also, then a simple revision of the drawing reflecting the changes is appropriate.

   If we have a mixed lot of parts where some meet specification and some parts deviate from the drawing, and/or future parts are to be fabricated per the original drawing, use options #2 or #3.

b. A new drawing may be created to define the deviating part. (with new drawing number and fabricated part clearly labeled)

c. A different item number may be assigned to each deviating part, with all deviations clearly defined on the original revised drawing. For example, the deviating part originally identified as Item #4 now may be identified as Item #16. Each fabricated part shall be clearly labeled.

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20.0 DRAWING INDEX NUMBERS

20.1 PURPOSE

Drawings at AEDC are assigned code numbers to assist in indexing and retrieval. This section describes the code and provides guidelines for assigning code numbers and using them to assist in retrieving existing drawings pertaining to specific AEDC facilities.

20.2 GENERAL DEFINITION

The codes identify each drawing with a specific two-digit Facility Code and an eight-digit Drawing Index Number. The Drawing Index Number is shown in the drawing title block and appears in the Metadata associated with the drawing package in Metaphase. The Facility Code appears in the Metadata only.

20.3 ESTABLISHING NEW CODE NUMBERS

When a new identification code is required, it is obtained by written request to Real Property Records, Contractor C. New numbers will be added to the lists in this standard by written request to the Chairman, Design Specification Working Group.

20.4 FACILITY CODES

The two-digit Facility Code is a unique number that identifies the AEDC facilities affected by the drawing. These codes are defined in the following table.

Facility Code	Facility Description	Facility Code	Facility Description
00	Miscellaneous	03	VKF and APTU
01	ETF B Plant (T-Cells)	04	Central Facilities
11	ETF A Plant (J1, J2, and J3 Cells)	06	VKF-CO (AEF)
12	ETF (J4, J5, and J6 Cells)	07	LPT (LORHO)
08	ETF C Plant (C1 and C2)	20	Research Cells
02	PWT		

20.5 DRAWING INDEX NUMBER CODES

The eight-digit Drawing Index Number identifies the specific portion of the facility affected by the drawing. This number is not unique but, when in conjunction with the Facility Code, does uniquely relate to a specific portion of a facility.

The following paragraphs and tables show the Drawing Index Numbers used with each Facility Code listed in the preceding table. The listing is by Facility Code in sequential order as given in the preceding table.

20.5.1 Miscellaneous Drawing Index Numbers (Facility Code 00)

The miscellaneous category includes those items which cannot be listed in Facility Codes 01, 11, 12, 02, 03, 04, 06, 07, 08, and 20. The listing of miscellaneous items is shown in Appendix A, Table 1.

20.5.2 ETF B-Plant Installation Drawing Index Numbers (Facility Code 01)

The ETF B-Plant (T-Cells) Drawing Index Number category includes all mechanical and electrical plant equipment, hydraulic oil systems, gaseous systems, water systems, steam systems, and miscellaneous test, shop, utility, and office buildings. The eight-digit number always begins with the digit 2. A numerical listing of the code numbers is shown in Appendix A, Table 2.

20.5.3 ETF T-Activity Test Operations Drawing Index Numbers (Facility Code 01)

The ETF T-Cell activity category includes mechanical, electrical, and instrumentation systems for the T1, T2, T3, T4 test cells, and all drawings which originated in research and staff offices. The eight-digit number always begins with the digit 3. A Drawing Index Number chart is shown in Appendix A, Table 3. The basic subdivision of the numbers is shown below.

Example of Number Breakdown

Field Division	Test Cell or Area	Category	Item or System
3	XX	XX	XXX
	(04)	(02)	(010)

For T-Activity, begin at Field Division 3 and follow line to test cell or area. T4 test cell is 04. For mechanical category, follow line to left to appropriate category. For electrical and instrumentation category, follow line to right to appropriate category. Mechanical service system is 02. From service system, follow line to item or system. Water is 010. Therefore, Drawing Index Number 30402010 is for the water system at T4 Test Cell.

20.5.4 ETF A-Plant Installation Drawing Index Number (Facility Code 11)

The ETF A-Plant (J1, J2, J3 Cells) Drawing Index Number category includes all mechanical and electrical plant equipment, hydraulic oil systems, gaseous systems, water systems, steam systems, fuel systems, and miscellaneous test, shop, utility, and office buildings. The eight-digit number always begins with the digit 1. A numerical listing of the numbers is shown in Appendix A, Table 4.

20.5.5 ETF J-Activity Test Operations Drawing Index Numbers (Facility Code 11)

The ETF J-Activity category includes mechanical, electrical, and instrumentation systems for the J1, J2, J3, J2a, and other test cells. The eight-digit number always begins with the digit 4. A Drawing Index Number chart is shown in Appendix A, Table 5. The basic subdivision of the number is shown below:

Example of Number Breakdown

Field Division	Test Cell or Area	Category	Item or System
4	XX	XX	XXX
	(02)	(02)	(010)

For J-Activity, begin at Field Division 4 and follow line to test cell or area. J2 test cell is 02. For mechanical category, follow line to left to appropriate category. For electrical and instrumentation category, follow line to right to appropriate category. Mechanical service system is 02. From service system, follow line to item or system. Water is 010. Therefore, Drawing Index Number 40202010 is for the water system at J2 Test Cell.

20.5.6 ETF J4 Installation Drawing Index Numbers (Facility Code 12)

The ETF J4 installation category includes all mechanical and electrical plant equipment, hydraulic oil systems, gaseous systems, water systems, steam systems, test fuel systems, and miscellaneous test, shop, utility, and office buildings. The eight-digit number always begins with the digits 11. A numerical listing of the Drawing Index Numbers is shown in Appendix A, Table 6.

20.5.7 ETF J5 Installation Drawing Index Numbers (Facility Code 12)

The ETF J5 installation category includes all mechanical and electrical plant equipment, gaseous systems, water systems, steam systems, test fuel systems, and miscellaneous test, service, and utility buildings. The eight-digit number always begins with the digits 12. A numerical listing of the Drawing Index Numbers is shown in Appendix A, Table 7.

20.5.8 ETF J6 Activity Test Operations Drawing Index Numbers (Facility Code 12)

The ETF J6 installation category includes all mechanical and electrical plant equipment, gaseous systems, water systems, steam systems, test fuel systems, and miscellaneous test, service, and utility buildings. The eight-digit number always begins with the digits 13. A numerical listing of the Drawing Index Numbers is shown in Appendix A, Table 8.

20.5.9 ETF J4, J5, J6 Activity Test Operations Drawing Index Numbers (Facility Code 12)

The ETF J4, J5, J6 activity includes mechanical, electrical, and instrumentation systems for the J4, J5, and J6 test cells. The eight-digit number always begins with the digit 5. A Drawing Index Number chart is shown in Appendix A, Table 9. The basic subdivision of the numbers is shown below:

Example of Number Breakdown

Field Division	Test Cell or Area	Category	Item or System
5	XX	XX	XXX
	(05)	(02)	(010)

For J4, J5, and J6 activity, begin at Field Division 5 and follow line to test cell or area. J6 Test Cell is 05. For mechanical category, follow line to left to appropriate category. For electrical and instrumentation category, follow line to right to appropriate category. Mechanical service system is 02. From service system, follow line to item or system. Water is 010. Therefore, Drawing Index Number 50502010 is for water system at J6 Test Cell.

20.5.10 **ETF C-Plant Activity Drawing Index Numbers (Facility Code 08)**

The ETF C-Plant category includes mechanical, electrical, and instrumentation systems for the C1, C2, air supply system, compressor system, cooler system, heater system, exhauster system, and miscellaneous test, shop, utility, and office buildings. The eight-digit number always begins with the digit 6. A Drawing Index Number chart is shown in Appendix A, Table 10. The basic subdivision of the numbers is shown below:

Example of Number Breakdown

Field Division	Test Cell or Area	Category	Item or System
6	XX (01)	XX (01)	XXX (010)

For C Test Cell activity, begin at Field Division 6 and follow to test cell or area. C-1 test cell is 01. For mechanical category, follow line to left to appropriate category. For electrical and instrumentation category, follow line to right to appropriate category.

Test Cell Hardware is 01. From test cell hardware, follow line to item or system. Calibrator is 010. Therefore, Drawing Index Number 60101010 is for the calibrator at C-Plant C1 Test Cell.

20.5.11 **PWT Drawing Index Numbers (Facility Code 02)**

The PWT Drawing Index Numbers are listed in seven tables with the numbers in each table shown in numerical order. The following is a listing of the categories with table numbers:

PWT Tunnels, Supports rakes, Etc.
See Appendix A, Table 11
PWT Buildings and Structures
See Appendix a, Table 12
Arc Heater
See Appendix A, Table 13
PWT Miscellaneous Research Cells and Equiipment
See Appendix A, Table 14
PWT Utility-Type Support Systems
See Appendix A, Table 15
PWT Instrumentation, Communications, and Computer Systems
See Appendix A, Table 16
PWT Fuel System
See Appendix A, Table 17

20.5.11 PWT Drawing Index Numbers (Facility Code 02)

20.5.12 VKF and APTU Drawing Index Numbers (Facility Code 03)

The index to VKF and APTU Drawing Index Numbers is located in the Carroll Building (Bldg. No. 1103) in the Sverdrup Design area. The index consists of six basic divisions which are identified by eight-digit numbers 10000000, 20000000, etc., and one division which accommodates the drawings which cannot be filed in the basic divisions. This division includes drawings such as balance calibration equipment which is not directly related to the building, test equipment, or plant equipment. Items such as balance calibration rigs, a bookcase, etc., would be classified as Other.

The divisions are subdivided into systems which are particular buildings or test equipment. Examples of these would be the Main Test and Laboratory Building or the "G" Range. The systems are subdivided into sections as needed, such as architectural or mechanical drawings, or the test equipment may be broken down as a range tube, blast tank, test section, etc. The sections are subdivided into groups which are basic components such as windows, actuators, flexible plates, or shock absorbers.

The number of breakdowns of a building or test equipment is dictated by the number of drawings or how it may be logically subdivided. The plant equipment index is different from the others in that the division, systems, and sections are identified by the first four digits rather than the first six. However, the basic method of subdividing is the same.

Example of Number Breakdown

Division	System	Section	Section Group
1	000	00	00

The index cover sheets in Appendix A, Table 18 will assist in locating a specific Drawing Index Number from one of five volumes located in the Mechanical Building, Room No. 110.

20.5.13 Central Facilities Installation Drawing Index Numbers (Facility Code 04)

The Central Facilities Installation category includes all buildings now shown in the ETF, PWT, or VKF categories -- natural gas mains, electrical distribution lines, steam distribution system, streets, roads, airfields, family housing, etc. The listing of these items is shown in Appendix A, Table 19.

20.5.14 VKF-CO (AEF) Plant Equipment Drawing Index Numbers (Facility Code 06)

The VKF-CO (AEF) plant equipment system category includes all mechanical and electrical plant equipment, gaseous systems, water system, steam system, solar simulator, etc., for the Mark I and Engineering Lab area. The eight-digit number always begins with the digit 1. A Drawing Index Number Chart is shown in Appendix A, Table 20. The basic subdivision of the numbers is shown below:

Example of Number Breakdown

Activity	Building	Area	Item or System	Document Type
1	XX (03)	XX (01)	XX (03)	X (4)

For VKF-CO (AEF) plant equipment, begin at plant equipment activity 1 and follow line to building, Mark I is 03. Then follow line to area. Buildings are 01. From area, follow line to item or system. Elevators are 03. From item or system, follow line to document type. Equipment location and installation is 4. Therefore, Drawing Index Number 10301034 is for elevator installation in the Mark I Building.

20.5.15 VKF-CO Research Cell Drawing Index Numbers (Facility Code 06)

The VKF-CO (AEF) research cell category includes the mechanical, electrical, and instrumentation research activities in the VKF-CO (AEF) area. The eight-digit number always begins with the digit 2. A Drawing Index Number chart is shown in Appendix A, Table 21. The basic subdivision of the number is shown below:

Example of Number Breakdown

Activity	Cell	Category
2	XXX (006)	XXXX (0100)

For VKF-CO (AEF) research cells, begin at activity 2 and follow line to cell. Small bell jar is 006. From cell, follow line to the left to mechanical category. Mechanical category is 0100. For electrical and instrumentation category, follow line to the right. Electrical and instrumentation category is 5000. Therefore, Drawing Index Number 20060100 is for mechanical components of the small bell jar research activity.

20.5.16 VKF-CO (AEF) Test Equipment Drawing Index Numbers (Facility Code 06)

The VKF-CO (AEF) test equipment category includes the mechanical, electrical, and instrumentation test equipment for the ARC 7V, ARC 10V, ARC 12V, Mark I Chamber, clean room, refrigeration room, instrument lab, etc. The eight-digit number always begins with the digit 3. A Drawing Index Number chart is shown in Appendix A, Table 20. The basic subdivision of the numbers is shown below:

Example of Number Breakdown

Activity	Test Cell or Area	Category	Item or System
3	XX	XX	XXX
	(04)	(05)	(020)

For VKF-CO (AEF) test equipment, begin at test equipment activity 3 and follow line to test cell or area. ARC 7V is 04. For mechanical category, follow line to left to appropriate category. For electrical and instrumentation category, follow line to right to appropriate category. Mechanical water system is 05. From water system, follow line to item or system. Flow diagram and schematic is 020. Therefore, Drawing Index Number 30405020 is for a waterflow diagram and schematic on ARC 7V Test Cell.

20.5.17 VKF-CO (AEF) Test Drawing Index Numbers (Facility Code 06)

The VKF-CO (AEF) category includes drawings related to tests conducted in the ARC 7V, ARC 10V, ARC 12V, Mark I Chamber, and other related areas. The eight-digit number always begins with the digit 4. A Drawing Index Number chart is shown in Appendix A, Table 23. The basic subdivision of the numbers is shown below:

Example of Number Breakdown

Activity	Chamber	Test
4	XX	XXXXX
(04)		61001

For VKF-CO (AEF) test, begin at test activity 4 and follow line to chamber. ARC 7V is 04. From chamber, follow line to test. Slip ring is 61001. Therefore, Drawing Index Number 40461001 is for the slip ring test in the ARC 7V Chamber.

20.5.18 LPT (LORHO) Drawing Index Numbers (Facility Code 07)

The LPT (LORHO) category includes all LORHO Pilot Tunnel, MHD, 5MW Arc Facility, Dust Erosion Tunnel, HEAT/H1 Arc Heater, and HEAT RENT Installation and test activities. The listing of these items is shown in Appendix A, Table 24.

20.5.19 Research Test Cells Drawing Index Numbers (Facility Code 20)

The research test cell category includes miscellaneous research arc chamber, electric propulsion pilot test facility, laser equipment, etc. The listing of these items is shown in Appendix A, Table 25.

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APPENDIX A
DRAWING CODE TABLES
(Reference Paragraph 20.0)

Table 1
Miscellaneous Drawing Index Codes (Facility Code 00)

Code	Item
00000001	Plant Equipment (incl. machine tools) or Special Fabrication Items
00000002	Instrument Equipment
00000003	Ion Engine Test
00000004	Welder Qualification
00000005	Fabricated Items for Electrical
00000006	Air Force Bob Sled
00000007	Humidity Controls
00000008	Rocket Gas Generator
00000009	Ultrasonic Test
00000010	Nuclear Electric Propulsion Pilot Lab Test Cell
00000012	High Enthalpy Test Facility

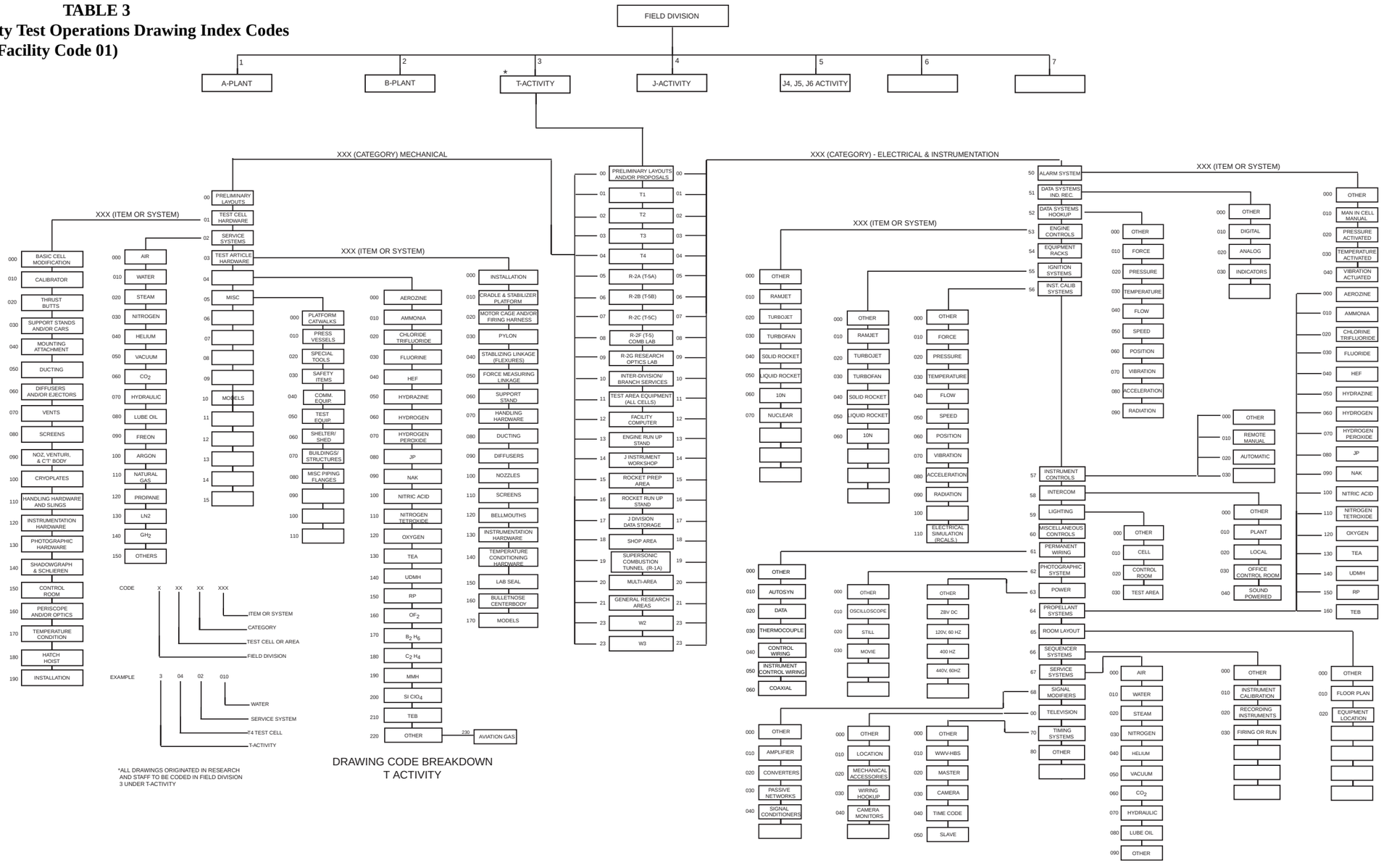
Table 2
ETF B-Plant Installation Drawing Index Codes (Facility 010)

Code	Item
20000001	Air and Gas Cooling Systems
20000003	Auxiliary Air Compressor System
20000004	Barometric Welss and Drainage System
20000006	Compressed Air System--Service, Switchgear and 2500 psig
20000008	Compressors and Drives
20000020	Controls and Instrumentation
20000102	Ducting--Airside-Compressor Area
20000104	Ducting--A and B Header and Test Area Inlet
20000110	Ducting--Test Chambers, Extensions and Details
20000111	Ducting--Exhaust-Yard and Exhauster Area
20000112	Ducting--Exhaust-Test Area
20000114	Ducting--Interconnecrting and Miscellaneous
20000116	Ducting Valves--Airside
20000118	Ducting Valves--A and B Header and Test area Inlet
20000120	Ducting Valves--Exhaust Side
20000130	Dynamometer System
20000201	Electrical--Control Rooms, Main and Local
20000203	Electrical--High Voltage (600 and 6900V) System including substations, Switchgear and Miscellaneous
20000205	Electrical--Low Voltage (120 and 440V) System including Building Services
20000207	Electrical--Schedules--Cable, Conduit, Junction Box, and Misc.
20000209	Electrical--Schematics--Compressor Area
20000211	Electrical--Schematics--Exhauster Area
20000213	Electrical--Schematics--Refrigeration
20000215	Electrical--Schematics--Test Area
20000217	Electrical-Schematics--Yard Area and Fuel Building
20000219	Electrical-Wiring Diagrams--Compressor Area
20000221	Electrical--Wiring Diagrams--Exhauster Area
20000223	Electrical--Wiring Diagrams Refrigeration Area
20000225	Electrical--Wiring Diagrams--Test Area
20000227	Electrical--Wiring Diagrams--Yard Area and Fuel Building
20000229	Electrical--Layouts, Conduit Details and Misc.--Compressor area
20000231	Electrical--Layouts, Conduit details and Misc.--Refrigeration Area
20000231	Electrical--Layouts, Conduit details and Misc.--Yard Area
20000235	Electrical--Layouts, Conduit Details and Misc.--Yard Area
20000237	Electrical--Layouts, Conduit Details and Misc.--Yard Area and Fuel Bldg.

Table 2. Concluded

Table Code	Item
20000239	Emergency Power (Generator) System
20000240	Equipment Locations
20000250	Exhausters and Drives
20000300	Flow Diagrams
20000350	Hydraulic Oil System
20000400	Intercommunication System
20000450	Lube Oil System
20000480	Nitrogen System
20000500	Refrigeration Machines
20000520	Refrigeration System, Glycol, Tichlorethylene and Miscellaneous
20000540	Steam System
20000545	Test Fuel and Demineralized Water System
20000550	Water System
20000560	Miscellaneous and Auxiliary Systems
20000830	Test fuel Metering Building
20000831	RTF 161 KV Substation No. 2
20000849	Warehouse
20000860	Fire Protection Systems
20000876	Shop Building
20000877	Office Building
20000878	Air Compressor and Test Building
20000879	RTF Exhauster Building
20000888	RTF 161 KV Substation No. 1
20000894	RTF High Pressure Fuel Building
20000900	Streets, Railroads and Utilities
29000560	Rocket Test Control Building
29000561	Rocket Engine Test Stand
21000000	T-3 Test Building

TABLE 3
ETF T-Activity Test Operations Drawing Index Codes
(Facility Code 01)



DRAWING CODE BREAKDOWN
T ACTIVITY

*ALL DRAWINGS ORIGINATED IN RESEARCH AND STAFF TO BE CODED IN FIELD DIVISION 3 UNDER T-ACTIVITY

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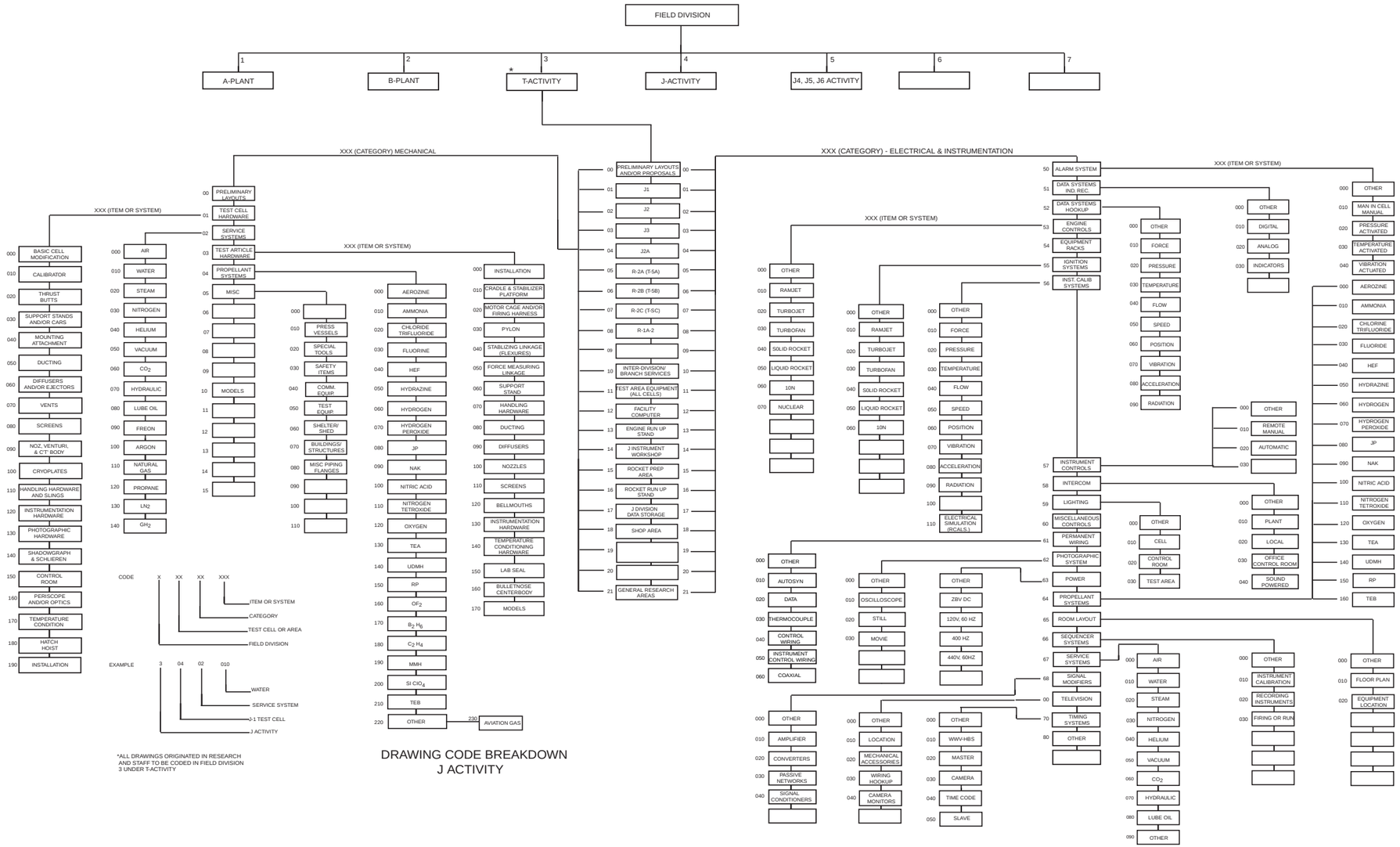
Table 4
ETF A-Plant Installation Drawing Index Codes (Facility Code 11)

Code	Item
10000001	Air and Gas Cooling Systems
10000004	Barometric Wells and Drainage Systems
10000006	Compressed Air Systems--Service, Stress Seal and Switchgear
10000008	Compressors and Drives
10000020	Controls and Instrumentation
10000030	Cryogenics Systems
10000101	Ducting--Continuous Air Supply
10000104	Ducting--A and B Headers
10000106	Ducting--Intermittent Air Supply
10000108	Ducting--Test Cell Air Supply
10000110	Ducting--Test Cells
10000112	Ducting--Test Cell Exhaust
10000113	Ducting--Exhaust System
10000114	Ducting--Interfacility
10000116	Ducting Valves--Continuous Air Supply
10000118	Ducting Valves--A & B Headers
10000120	Ducting Valves--Intermittent Air Supply
10000122	Ducting Valves--Test Cell Air Supply
10000124	Ducting Valves--Exhaust System
10000205	Electrical--Building Services
10000208	Electrical--Schematics
10000218	Electrical--Wiring Diagrams
10000229	Electrical--Operational Power--Layouts--Air Supply Area
10000230	Electrical--Operational Power--Layouts--Test Area
10000231	Electrical--Operational Power--Layouts--Exhaust Area
10000232	Electrical--Miscellaneous
10000238	Electrical--DC Distribution System
10000239	Emergency Power System
10000240	Equipment Locations
10000250	Exhausters and Drives
10000300	Flow Diagrams
10000310	Foundations and Miscellaneous Structures
10000320	Heaters--Intermittent Air Supply
10000330	Heaters--Continuous Air Supply
10000350	Hydraulic Oil Systems
10000400	Intercommunications System

Table 4. Concluded

Code	Item
10000520	Refrigeration System
10000540	Steam System
10000545	Test Fuel Systems
10000550	Water Systems
10000560	Miscellaneous and Auxiliary Systems
10000648	Centaur Building
10000832	Helium Compressor Building
10000833	J-3 Maintenance Building
10000843	Fire Protection Systems
10000868	J-2A Test Control Building
10000880	Test Building
10000881	Air Supply Building
10000882	Exhauster Building
10000883	161 KV Substation
10000884	Refrigeration Building
10000885	Heater Control Building
10000886	Pressure Reducing StationBuilding
10000887	Blower Building
10000889	Water Spray Pump House
10000890	Hydraulic Equipment Building
10000891	Electric Utility Tunnel
10000892	Valve House
10000893	Tunnel Structure for Air Lines
10000894	Cryogenics Building
10000895	J-3 Instrument Huts
10000896	J-3
10000897	Valve Degreaser Building
10000900	Streets, Railroads, Utilities
10002896	Air Compressor and Test Rig

TABLE 5
ETF J-Activity Test Operations Drawing Index Codes
(Facility Code 11)



*ALL DRAWINGS ORIGINATED IN RESEARCH AND STAFF TO BE CODED IN FIELD DIVISION 3 UNDER T-ACTIVITY

DRAWING CODE BREAKDOWN
J ACTIVITY

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Table 6
ETF J4 Installation Drawing Index COdes (Facility Code 12)

Code	Item
11000001	Air and Gas Cooling Systems
11000004	Drainage Systems and Pumps
11000020	Controls and Instrumentation
11000110	Ducting--Test Cells
11000112	Ducting--Test Cell Exhaust
11000124	Ducting Valves--Exhaust System
11000125	Elevator (Underground)
11000205	Electrical--Building Services
11000208	Electrical--Schematics
11000218	ELectrical--Wiring Diagrams
11000230	Electrical--Layouts
11000232	Electrical--Miscellaneous
11000300	Flow Diagrams
11000310	Foundations and Miscellaneous Structures
11000311	J4 Spray Chamber (including Elevator Shaft, Interconnection and Equipment Room)
11000350	Hydraulic System
11000400	Intercommunication Systems
11000480	Nitrogen System
11000519	J4 Hydraulic Building
11000520	Rocket Test Cell Control Building
11000521	LRF Test Storage Building
11000528	J4 and J5 Water Softener Building
11000529	J4 Thrust Calibration Equipment Building
11000533	Outside Overhead Crane and Elevator
11000534	J4 Data Conditioning Building
11000535	J4 and J5 Steam Generating Building
11000536	J4 Service and Support Building
11000537	Rocket Storage Building
11000538	Rocket Preparation Building
11000540	Steam Systems
11000542	Steam Systems--J3 Accumulators
11000545	Test Fuel Systems (includes LOX)
11000550	Water Systems
11000551	Water Storage Tanks
11000560	Miscellaneous and Auxiliaary Systems
11000567	Gaseous Helium Storage and Compressor Building

Table 6. Concluded

11000569	Power distribution Center Building
11000600	Proposed J8 Test Cell (entire plan)
11000601	Proposed J6, J7A, J7B, and J9 Test Cells
11000843	Fire Protection Systems
11000900	Streets, Railroads and Utilities
11001100	J4 and J5 Engineeering Lab Building
11002215	Rocket Preparation Building

Table 7
ETF J5 Installation Drawing Index Codes (Facility Code 12)

Code	Item
12000000	Miscellaneous
12000001	Air and Gas Cooling Systems
12000002	Air Conditioning Systems
12000004	Drainage Systems
12000020	Controls and Instrumentation
12000110	Ducting--Test Cell
12000112	Ducting--Test Cell Exhaust
12000124	Ducting Valves--Exhaust Side
12000205	Electrical--Building Services
12000208	Electrical--Schematics
12000218	Electrical--Wiring Diagrams
12000230	Electrical--Layouts
12000232	Electrical--Miscellaneous
12000300	Flow Diagrams
12000310	Foundations and Miscellaneous Structures
12000400	Intercommunication
12000480	Nitrogen System
12000524	Electrical Service Building
12000526	Mechanical Service Building
12000527	J5 Substation
12000533	Shelter and Overhead Crane
12000537	J5 Steam and Water Valve Shelter
12000538	J5 Arming Hut
12000539	J5 Local Control Center Building
12000540	Steam Systems

Table 7 Continued

Code	Item
12000545	Test Fuel Systems
12000560	Miscellaneous and Auxiliary Systems
12000843	Fire Protection Systems
12000900	Streets, Railroads and Utilities

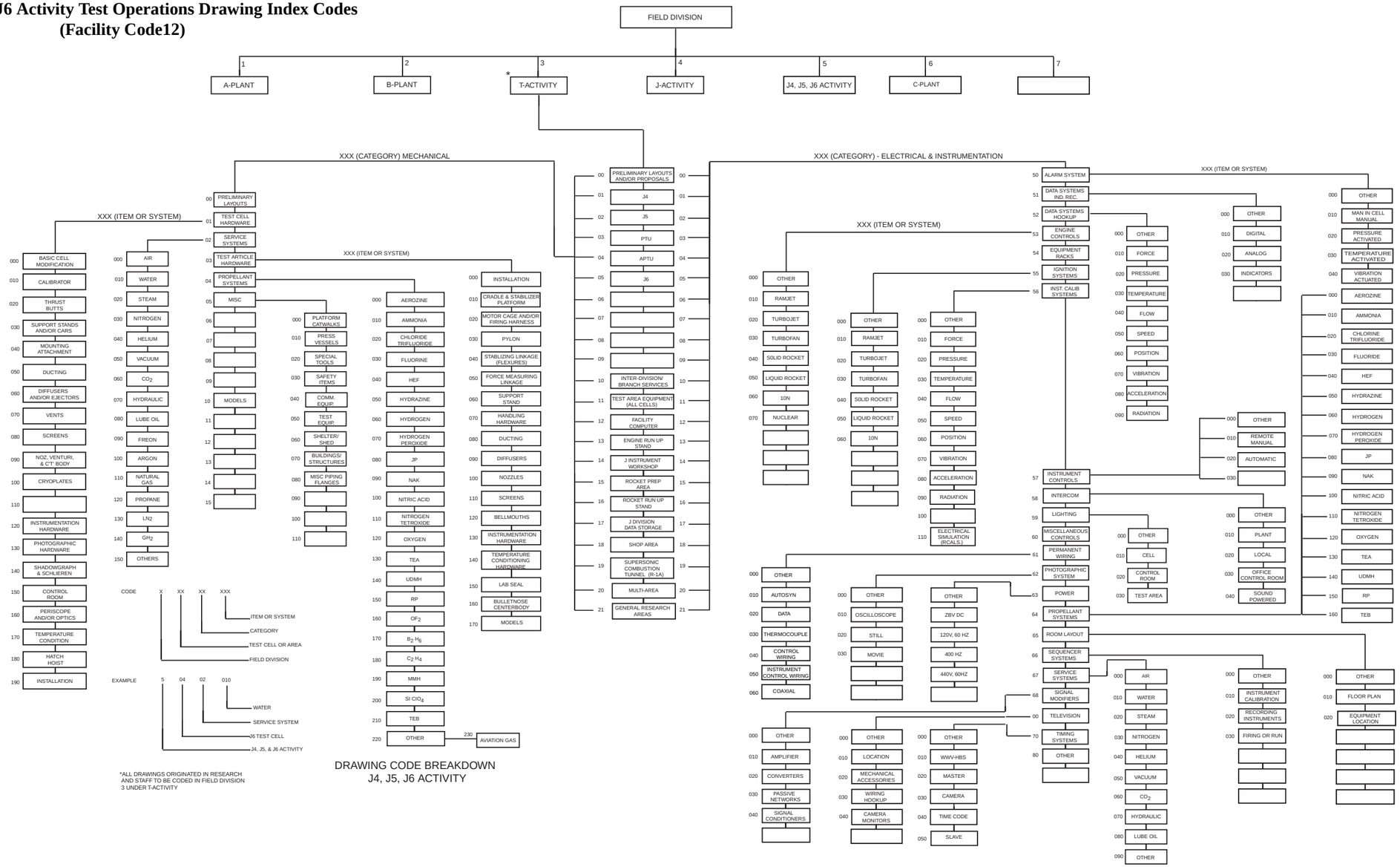
Table 8
ETF J6 Installation Drawing Index Codes (Facility Code 12)

Code	Item
13000000	Miscellaneous
13000001	Air and Gas Cooling System
13000002	Air Conditioning and Ventilation Systems
13000004	Drainage Systems and Pumps
13000006	Compressed Air System
13000019	Data Acquisition System
13000020	Controls and Instrumentation
13000021	Test Control Verification System
13000022	Analog Data Acquisition System
13000023	Oscillographs
13000024	Data Logger
13000025	Photographic System
13000026	Television and Video
13000027	Equipment Racks and Consoles
13000028	Instrumentation Permanent Interconnect
13000029	Test Area Controller
13000030	Alarm Systems
13000031	Controls Permanent Interconnect
13000032	Ordnance Systems
13000033	Thrust Vector Control System
13000034	Test Control Sequencer
13000035	Uninrerruptible Power Systems
13000036	Process System Controls
13000110	Ducting--Test Cells
13000120	Ducting--Rocket and Steam Ejector Diffusers
13000121	Ducting--Saturation Cooler
13000124	Ducting --Valves--Exhaust System
13000125	Elevator

Table 8. Concluded

Code	Item
13000205	Electrical--Building Services
13000208	Electrical--Schematic
13000218	Electrical--Wiring Diagrams
13000230	Electrical--Layouts
13000232	Electrical--Miscellaneous
13000300	Flow Diagrams
13000310	Foundations and Miscellaneous Structures
13000350	Hydraulic Systems
13000400	Intercommunication Systems
13000480	Nitrogen Systems
13000520	Control Building Addition
13000527	Substation
13000533	Cranes and Hoists (Bridge, Job and Manual)
13000538	Rocket Preparation Building
13000540	Steam Generation Systems (Plant and Accumulators)
13000542	Steam Distribution Systems
13000545	Test Fuel Systems
13000550	Water Systems
13000560	Miscellaneous and Auxiliary Systems
13000563	Steam Generating Building
13000570	Force Measurement System
13000583	Fire Protection System
13000900	Streets, Railroads and Utilities
13000910	Test Cell Systems
13000920	Water Chiller
13002120	Test Storage Building
13002123	Local Electronics Building
13002124	Test Cell Enclosure Building
13002126	Ducting--Exhaust
13002127	Dehumidification Cooler
13002128	Water Storage Tank
13002132	Steam Control Valve Building

TABLE 9
ETF J4, J5, & J6 Activity Test Operations Drawing Index Codes
(Facility Code12)



*ALL DRAWINGS ORIGINATED IN RESEARCH AND STAFF TO BE CODED IN FIELD DIVISION 3 UNDER T-ACTIVITY

DRAWING CODE BREAKDOWN
J4, J5, J6 ACTIVITY

TABLE 10
C-Plant Activity Drawing Index Numbers
(Facility Code 08)

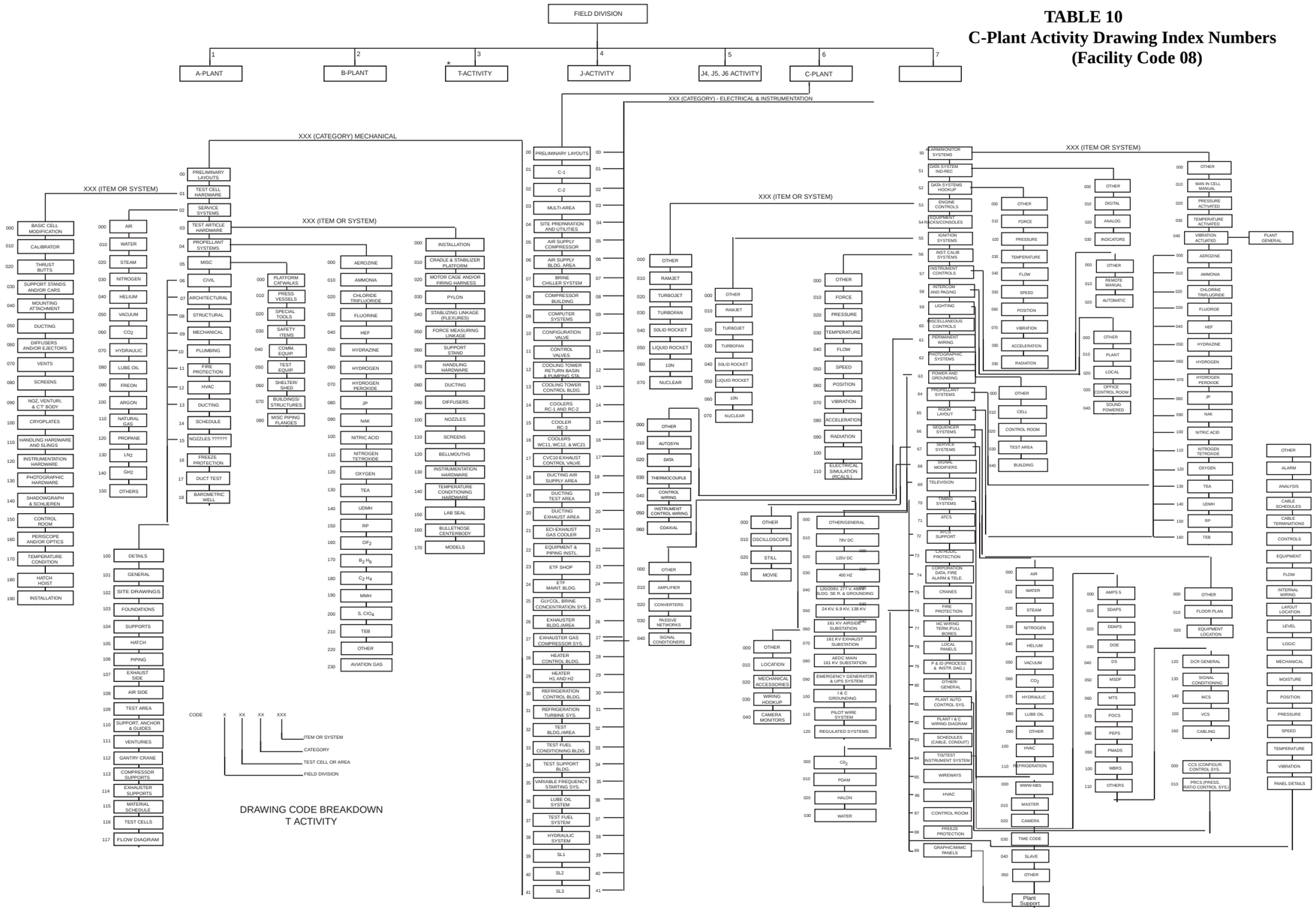


Table 11
PWT Tunnels, Supports, Rakes, Etc. Drawing Index Codes
(Facility Code 02)

Code	Item
02010000	Miscellaneous
02010001	Main Drive System (includes Compressors C1 thru C5)
02010002	16S Compressors and Steel Blades
02010003	16T Comprerssors and Plastic Blades
02010004	16S Compressors and Plastic Blades
02021000	Internal Static and Dynamic Balances
02021001	Dynamic Internal Balances
02021002	Dynamic External Balances
02021003	Static Internal Balances
02021004	Static External Balances
02022000	Struts and Supports, 4T
02022001	Sting Support System, 16S
02022002	Sting Support System, 16T
02022003	Sting Support System, 1S
02022004	Sting Support System, 1T
02022005	Stings and Adaptors, 16T and 16S
02022006	Stings and Adaptors, 1S and 1T
02022007	Struts and Supports, 16T
02022008	Struts and Supports, 16S
02022009	Struts and Supports, 16S and 1T
02022010	Rakes, 16S
02022011	Rakes, 16T
02022012	Rakes, 1S
02022013	Rakes, 1T
02022014	Rakes, 4T
02022015	Sting Support System, 4T
02022016	Sting and Adaptors, 4T
02022017	Captive Trajectory System, CTS -- 4T
02022018	High Angle Automated System, CTS-16TS
02022019	Captive Trajectory System, CTS-16T/S
02022020	Pitch Boom, 16T
02022021	Flexible Nozzle, 4T
02022022	Independent Drive System, 4T (4T-IDS)
02023000	Calibration Equipment, Guy Rods, Cable Loading System, Etc.
02023001	Calibration Equipment, 16S and 1S

Table 11 Continued

Code	Item
02023002	Calibration Equipment, 16T, 1T and 4T
02024001	Models and Equipment--Special Test, 16S
02024002	Models and Equipment--Special Test, 16T
02024003	Models and Equipment--Special Test, 1S
02024004	Models and Equipment--Special Test, 1T
02024005	Models and Equipment--Special Test, 4T
02025000	General Purpose Non-Test Equipment
02026000	External Balances, Support Systems, 16S Centerline Probe, Etc.
02026001	Probes--General
02026002	Probes--16S
02026003	Probes--16T
02026004	Probes--1S
02026005	Probes--1T
02026006	Probes--4T
02030000	Plenum Evacuation System
02031000	Plenum Transition Ducting
02040000	Tunnel Conditioning System
02044000	4-Ft. Tunnel
02045000	Transonic Tunnel, Ducting, and Foundations
02045001	Scavenging Scoop Tips--16T
02046000	Supersonic Tunnel, Ducting, and Foundations
02046001	Scavenging Scoop Tips--16S
02049000	Transonic and Supersonic Valves
02054000	Transonic Nozzle
02054001	Supersonic Nozzle
02055000	Test Section Diffusers
02060000	Transonic Test Carts and Calibration Carts
02061000	Supersonic Test Carts
02062000	Transfer Car and Tracks
02063000	Transonic Model Tunnel
02063001	Scavenging Scoop Tips--1T
02064000	Supersonic Model Tunnel
02064001	Scavenging Scoop Tips--1S
02070000	Scavenge and Make-Up Air system

Table 11Concluded

Code	Item
02100001	General Building Material and Equipment
02100005	Mechanical Equipment
02100006	Electrical Equipment
02100072	Auxiliary High Pitch Support System
02300033	Schlieren System
02300047	Rocket Engines
02300048	Rocket Injectors
02300053	Plant Operations Sketches
02300062	Test Section 16S
02300063	Test Section 16T
02300064	Diffuser 16S
02300065	Diffuser 16T

Table 12
PWT Buildings and Structures Drawing Index Codes
(Facility Code 020

Code	Item
02030001	Supersonic Compressor Equipment building (702)
02030002	Outside Overhead Crane Structure (711-2)
02030003	Supersonic Tunnel Underpass (705)
02030004	Valve 14 Control House (704)
02300004	Plenum Evacuation Motor Building (710)
02300005	Plenum 161 KV Substation (719)
02300006	Transonic tunnel Underpass (730)
02300007	PWT Main 161 KV Substation (732)
02300008	PWT Office Building (740)
02300009	Supersonic Control Building (745)
02300010	Utilities Shelter for Fuel System--Supersonic Circuit (749)
02300011	Test Fuel Building (750)
02300012	Utilities Tunne. (711-4)
02300013	Model Installation Building (760)
02300014	Cart Stand Build-Up (775)
02300015	Motor Drive Building (780)
02300016	Test Fuel Valve Building--Transonic Circuit (781)
02300017	LPG Vaporizer Building(782)

Table 12. Concluded

Code	Item
02300018	Air Filter Building (783)
02300019	Desiccant Drier Building (784)
02300020	Transonic Control Building (785)
02300021	Rotor Erection Building (786)
02300022	Static Rocket Control Building (787)
02300023	Rocket Engine Test Stand (789)
02300024	Water Treatment Building (790)
02300025	Nozzle Pump House--Supersonic Circuit (712)
02300028	Streets, Railroads, and Utilities
02300030	Purge Water Treatment Building (708)
02300031	Transonic Model Tunnel Building (1416)
02300032	PES Substation Control House (720)
02300036	Instrumentation Tunnels
02300037	Barometric Wells
02300039	Temporary Structures
02300041	T. E. A. Slug Tank Building
02300042	Transonic Model Tunnel Substation
02300051	Cooler No. 2 valve shelter (734)
02300052	Cooler No. 3 Valve Shelter (735)
02300054	Hydraulic Test Stand
02300635	Research Lab (Old X-Ray Building) (635)
02300709	4T Test Cell building (707)
02300713	Rigging Equipment Building (16S)(713)
02300721	HTL Reactor Building (721)
02300746	Supersonic Hydraulic Pump House (746)
02300755	GE 1 Coolant Pit Building (755)
02300788	Transonic Hydraulic Pump House (788)
02300792	Compressor Blade Test Stand
02300793	Acoustic Research Building (793)
02300794	Compressor Parts Building (794)
02300796	Desiccant Drier Building (796)
02300874	PWT Induction Heater Building (LORHO Battery) (874)
02300791	Welding Shop (791)

Table 13
Arc Heater drawing Index Codes (Facility Code 02)

Code	Item
02011000	Research Arc Heater Cell
02012000	N 4000 Arc Heater

Table 14
PWT Miscellaneous Research Cells and Equipment Drawing Index Codes (Facility Code 02)

Code	Item
02047000	V/STOL Pilot Tunnel
02013000	Cold Wall Test Cell
02024006	Models and Equipment--Special Test V/STOL Pilot Tunnel
02024007	Sting Support System--V/STOL Pilot Tunnel
02100013	Electron Gun
02100016	4 MW Induction Heater
02300060	Cold Wall Vacuum Cell
02300061	True Temperature Tunnel
02300067	Acoustic Test Cell

Table 15
PWT Utility-Type Support systems Drawing Index Codes (Facility Code 02)

Code	Item
02023003	Hydraulic Power Supply--16S and 16T
02040001	Cryogenics Cooling System
02050000	Test and Support Utilities
02051000	Test Power and Distribution System
02053000	Fire and Explosion Protection System
02100002	Fire Protection Equipment and Supplies
02300026	Purge Water Supply System
02300027	Desiccant Drier System
02300034	Raw Water System--Transonic Tunnel
02300035	Raw Water System--Supersonic Tunnel
02300040	Propane System

Table 16
PWT Instrumentation, Communications, and Computer Systems
Drawing Index codes (Facility Code 02)

Code	Item
02010800	Computer M. G. Sets
02019000	Intercommunications System
02100003	Plant Control and Instrumentation Equipment
02100004	Test Instrumentation
02100029	Controls and Instrumentation
02300038	ERA Computer and Raytheon Computer
02300043	Instrumentation--16S
02300044	Instrumentation--16T
02300045	Instrumentation--1S
02300046	Instrumentation--1T
02300049	Instrumentation
02300066	Instrumentation--4T

Table 17
PWT Fuel Systems Drawing Index Codes (Facility Code 02)

Code	Item
02052000	Test Fuel System
02052001	TEA and TEB Systems--16S
02052002	TEA and TEB Systems--16T
02052003	TEA and TEB Systems--1S
02052004	TEA and TEB Systems--1T
02052010	Rocket Fuel System--16S
02052011	Rocket Fuel system--16T

Table 18
VKF Drawing Index Codes Index
(Facility Code 03)

Index to VKF

Index No.	**Title**
Buildings and Grounds	
10000000	General
10000101	Ducting - Continuous Air Supply
10010000	Grading Plan And Block Plan Layout
10020000	**Main Test And Laboratory Building**
10020100	Architectural
10020200	Structural And Civil
10020300	Electrical
10020400	Mechanical
10020500	Crane
10029900	Others And Miscellaneous
10030000	**Compressor Building**
10030100	Architectural
10030200	Structural And Civil
10030300	Electrical
10030400	Mechanical
10030500	Crane
10030600	Compressor Foundations
10030700	Other Foundations
10032000	**Compressor Building Addition**
10032001	Architectural
10032002	Structural And Civil
10032003	Electrical
10032004	Mechanical

Index to VKF - Continued

Index to VKF - Continued

Index to VKF - Continued

Index to VKF - Continued

Index to VKF - Continued

Index to VKF - Continued

Index to VKF - Continued

Index to VKF - Continued

Index to VKF - Continued

Test Equipment

Index to VKF - Continued

Index to VKF - Continued

Index to VKF - Continued

Index to VKF - Continued

Index to VKF - Continued

Index to VKF - Continued

Index to VKF - Continued

Index to VKF - Continued

Index to VKF - Continued

Index to VKF - Continued

Index to VKF - Continued

Index to VKF - Continued

Index to VKF - Continued

Index to VKF - Continued

Instrumentation

Index to VKF - Continued

Index to VKF - Continued

Electrical And Controls

Index to VKF - Continued

Index to VKF - Continued

Index to VKF - Continued

Index to VKF - Continued

Index to VKF - Continued

Index to VKF - Continued

Models And Related Equipment

Index to VKF - Continued

Index to VKF - Continued

Index to VKF - Continued

Index to VKF - Continued

Index to VKF Concluded

Table 19. VKF-CO (AEF) Plant Equipment Draing Index codes (Facility Code 06)

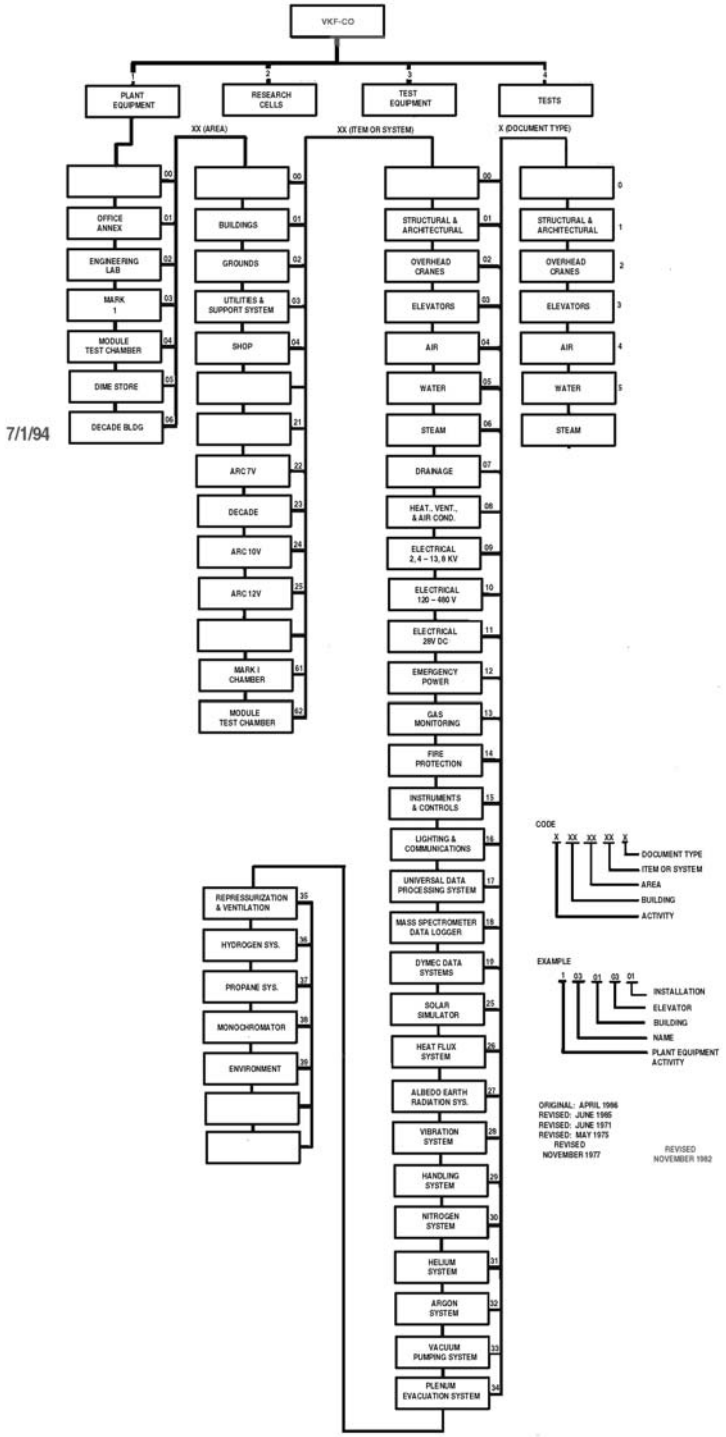


Table 20
VKF-CO (AEF) Research Cell Drawing Index Codes
(Facility Code 06)

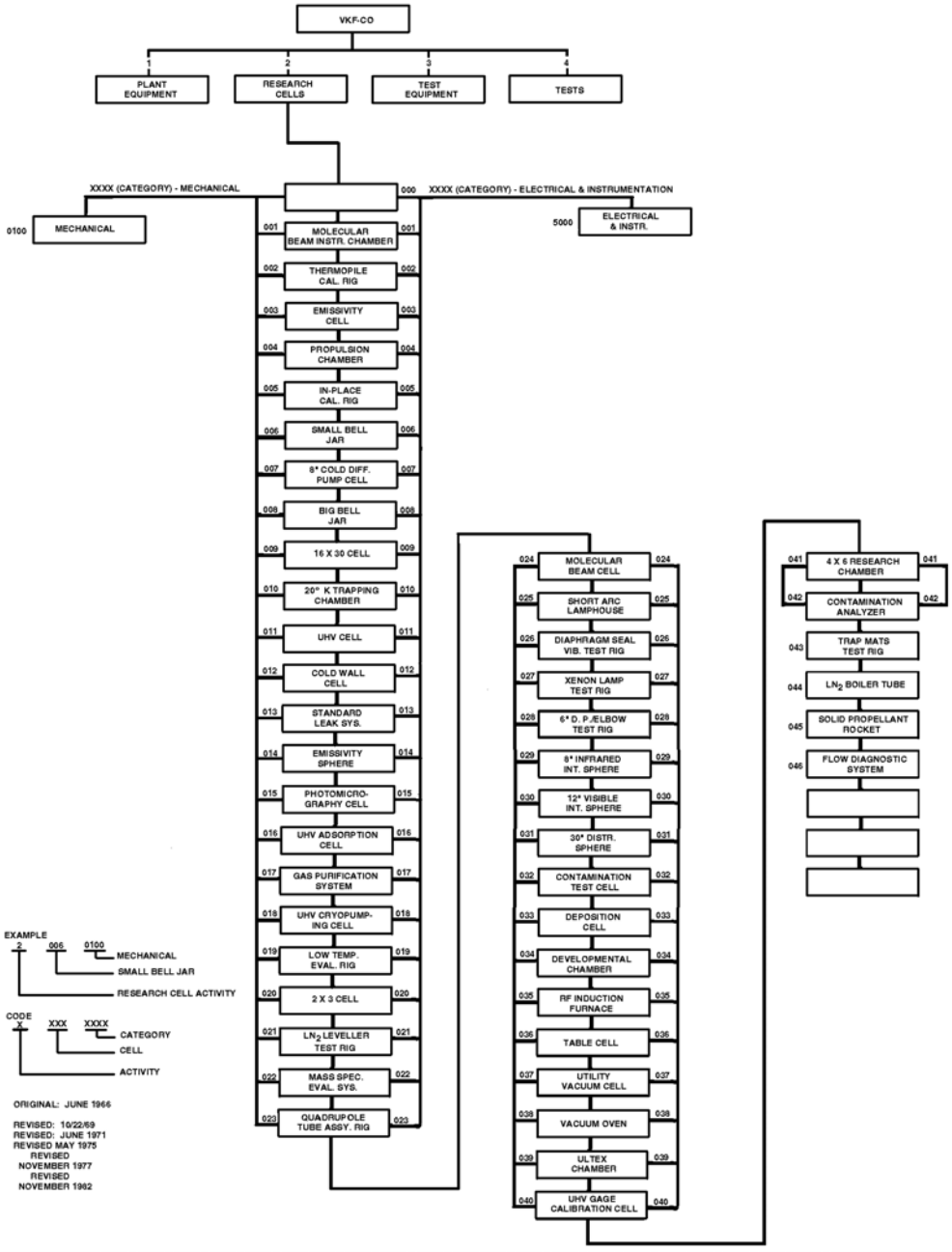


Table 21.
VKF-CO (AEF) Test Equipment Drawing Index Codes
(Facility Code 06)

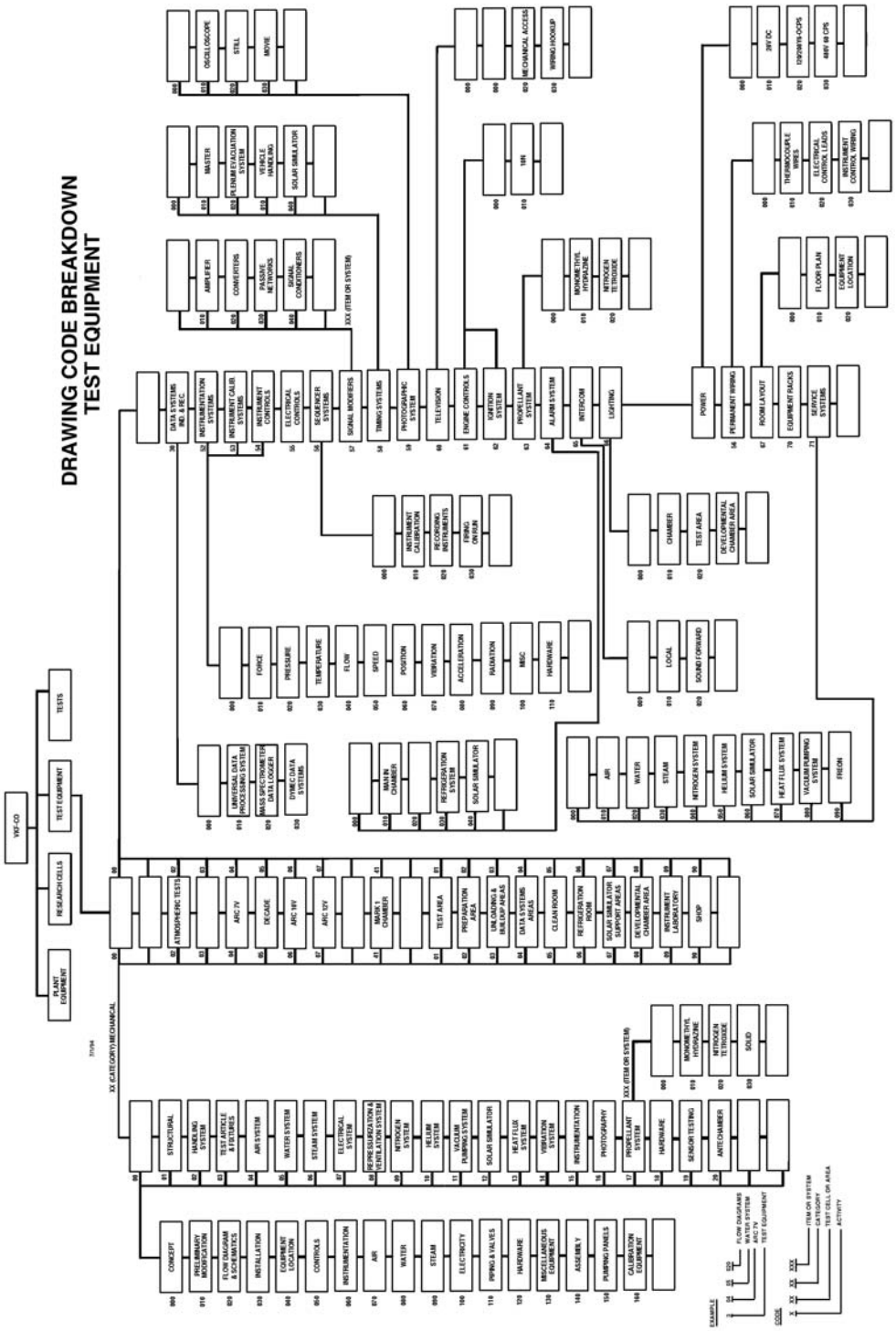


Table 22
VKF-CO (AEF) Test Drawings Index Codes
(Facility Code 06)

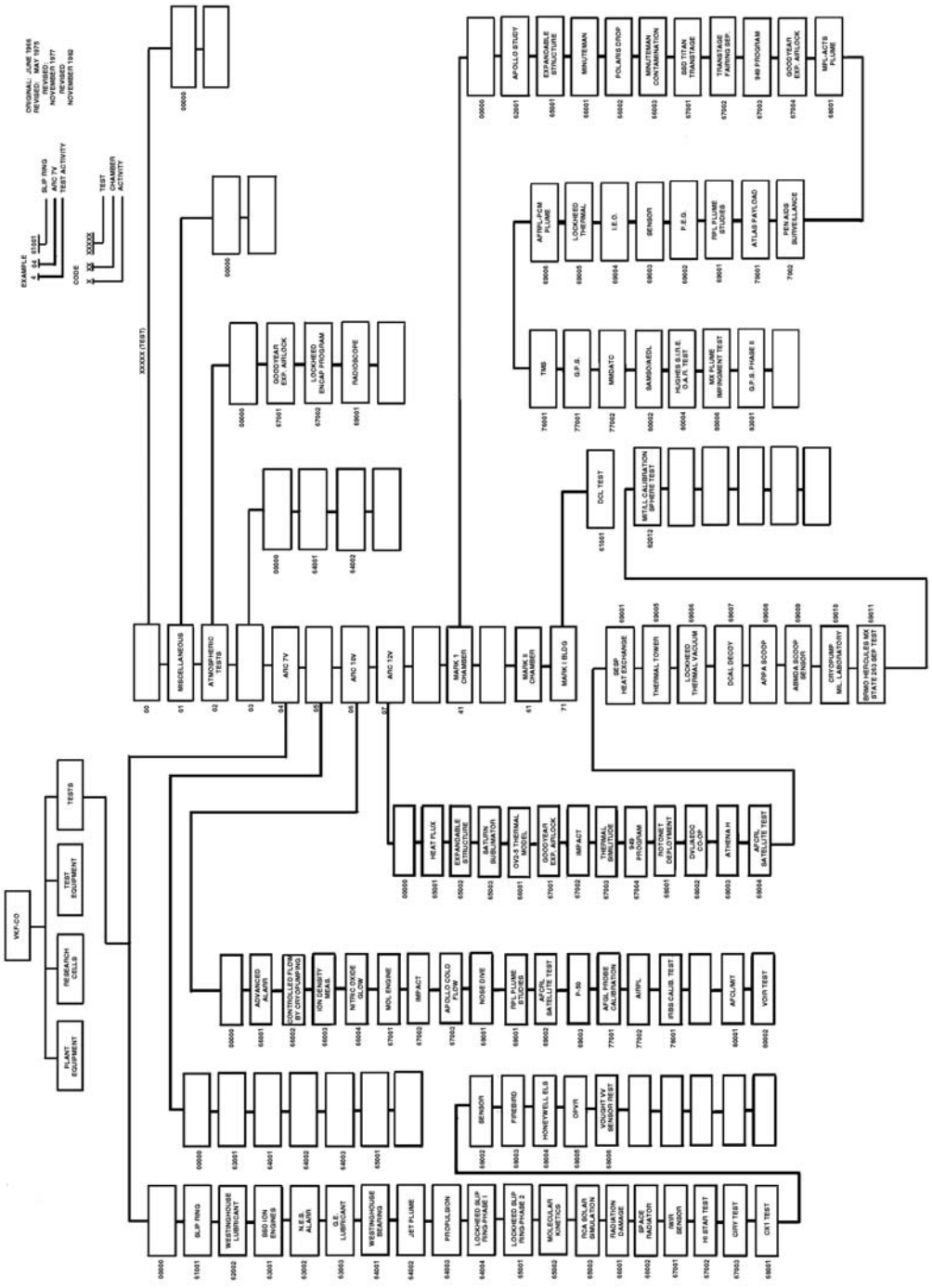


TABLE 23
LPT (LORHO) Drawing Index Codes
(Facility Code 07)

Code	Item
02100007	20-MW Generator System and Dummy Channel
02100008	Accelerator Channel and H-Magnet
02100009	ARC Heater System
02100010	10-MW Heater (Multi-Arc)
02100012	TTT Pilot Storage Heater
02100014	MHD Accelerator (2-MW LORHO)
02100015	5-MW Arc Facility
02100020	Dust Erosion Tunnel
02100050	LORHO Pilot Tunnel
02100051	LORHO Pilot Tunnel (ETF T-5 Area)
02100066	Special Test -- LORHO Pilot Tunnel
02100067	HEAT Facility
02100068	EOS 5-MW Arc Heater
02100069	MHD Performance Demonstration
02100070	Models and Equipment Special Test -- 5 MW Arc Heater
02100071	Models and Equipment special Test -- DET
02100077	20-MW Arc Heater System (H-1)
02100078	MHD System
02100080	RENT Arc Heater System (H-R)
02100081	Models and Equipment Special Test -- H-1/HEAT Facility
02100082	Models and Equipment Special Test -- RENT/HEAT Facility
02100083	N-4 Arc Heater -- RENT/HEAT Facility
02100084	H3 ARC Heater System
02100085	H1-T Segmented ARC Heater System
02100718	LORHO High Temperature Lab Shop Building (718)
02300001	LORHO Pilot at ETF AC&T Building
02300722	PWT High Temperature Building (722)
02300726	PWT Fuel Storage Building (726)

Table 24
Research Test Cells Drawing Index Codes
(Facility Code 20)

Code	Item
44000001	Miscellaneous
44000004	4 × 4 V Arc Chamber
44000006	Electric Propulsion Pilot Test Facility
44000008	Steam Ejection Study in T5C2
44000010	Electro Propulsion System Development
44000012	Magnetohydrodynamic Flow Loop
44000015	Laser Equipment
44000016	Collector System (ETF Shop Bldg.)
44000020	Supersonic Compressor Test
44000030	3 Axis Traverse Machine

TABLE 25
Central Facilities Installation Drawing Index Codes
(Facility code 04)

Code	Item
04000000	Miscellaneous
04000002	Portable Structures
04000004	Fabricated Plant Equipment and Tanks
04000006	Plant Equipment Details
04000008	Real Estate (Land) Surveys and Monuments
04000010	Computer Cable between Facilities
04000100	A & E Building (100)
04000101	Flag Poles and Dedication Markers (101 & 102)
04000111	Credentials Building (111)
04000125	Base Commissary Warehouse (125)
04000151	Gate Houses (151, 1751)
04000225	Dispensary Building (225)
04000251	FP&C Building (251)
04000253	Special Projects Building (253)
04000255	Fire Towers (255)
04000256	Communications Transmitter Building (256)
04000257	Radio Towers (257)
04000258	Small Arms Ammunition Building (258)
04000261	FP&C Air Compressor building (261)
04000265	Classified Waste Incinerator (265)
04000350	Propulsion Lab Instr. Bldg. and Substation (350 & 349)
04000351	Elevated Water Tanks (351)
04000376	Construction Power Substation (not in use)
04000380	Sewerage Lift and Ejector Stations -- Tunnels G & U (380)
04000390	Force Flow and Dynamic Building (390)
04000391	Flammable Materials Storage Building (391)
04000438	Vapor Degreaser Building (438)
04000440	Riggers Building (440)
04000444	Pipe Shop and Reclamation Storage Building (444)
04000445	Tech Lab -- Fuel Analysis Building (445)
04000446	Vapor Degreaser Building and Pickling Tanks (446)
04000447	Shed for Flame Cutting Bench (447)
04000448	Old Vapor Degreaser Bldg.) (448)-demolished
04000449	Model Shop Substations (449, 490)
04000451	Model Shop Building (451)

TABLE 25 Continued

04000452	Main Cafeteria Building (452)
04000453	Main Cafeteria Substation (453)
04000454	Base Exchange (454)
04000570	Rocket Storage Area (near Gate 5) (570)
04000591	J6 Field Office Building (591)
04000620	TDF Building (Cow Barn) (620)
04000645	Warehouse Bldg. (N. side of Third St.) (645)
04000646	Old CE Soils Lab (646)
04000685	Warehouse Bldg. (E. of VKF MT&L Bldg.) (685)
04000733	Central Nitrogen Building and Distribution Lines (733)
04000800	Builk Helium Storage Building and System
04000864	Food Stand (644)-demolished
04000869	Test Fuel Pump House (869)
04000870	Test Fuel Farm Storage Tanks, Unl9ading Platforms, Distribution Piping and Fire Protection System (near ETF) (870)
04000871	Test Fuel Farm House (871)
04000873	Fuel Farm Maintenance Building (873)
04000875	Street Light Substation (at ETF Shop Bldg.) (875)
04000939	Plume Data Center (939)
04001103	Carroll Building (1103)
04001358	Physical Fitness Center (1358)
04001400	Automative Repair shop (1400)
04001401	Locomotive Maintenance and Storage Shed (1401)
04001402	Tire Storage building and Unloading Platform (1402)
04001403	Warehouse, Rear IM bldg., Paint & Chemical Storage Yard, Rear Model Shop
04001405	Vehicle Fueling Pumps, Gasoline Storage Tanks, Diesel Fuel Storage Tanks (1405, 1406, 1407)
04001410	Steam Plant, coal Yard, Oil Tanks (1410, 1411, 1413)
04001421	Warehouse (MK Area)
04001424	ODC Center (1424)
04001426	Recycling Center (1426)
04001428	Warehouse 8 (1428)
04001433	5th Street Office Building (Little Tin Bldg)
04001456	Hazmat Storage Facility (1456)
04001459	Hazmat Pharmacy (1459)
04001460	Hydrogen Peroxide Shed (1460)
04001461	Waste Oil Minimization Facility (1461)
04001470	Lumber Storage Shed (1470)
04001472	Sandblast Shelter (1472)

TABLE 25 Continued

04001473	Warehouse Bldg. (along RR south of S & R Warehouse) (1473)
04001475	Scales and Scale House (1475)
04001476	Shipping and receiving Waehouse (1476)
04001477	Warehouse No. 2 (1477)
04001478	Installation Maintenance Bldg. (1478)
04001481	Supply and Equipment shed -- Rigger's Shack (1481)
04001485	Calcium Chloride Storage building (1485)
04001503	Water Treaatment Plant and Clearwells (1503 & 1504)
04001506	Secondary Reservoir (1506)
04001508	Secondary Pumping Plant (1507 & 1508)
04001509	Secondary Pumping Plant Substations (1509 & 1510)
04001520	Volatile Liquids Storage Building (1520)
04001521	Gas Cylinder Storage Buildings -- West & Ed St., No. 3 (1521, 1528, and 1532)
04001525	Power Control Building (1525)
04001526	Oil Pump House (in Main Substation) (1520)
04001527	Paint and Chemical Storage Building (1527)
04001529	Transformer Oil Storage Tanks (1529)
04001530	Shed on Southwest side of Paint & Chemical Storage Yard (1530)
04001531	Meteoroligical Tower (1531)
04001532	Gas Cylinder Storage Sheds (1532)
04001533	Truck Shelter (1533)
04001545	Diversion Structure in Cooling Water Return Ditch (1545)
04001546	NPDES Station #5
04001552	Sewage Plant (1552)
04001553	Sewage Treatment Plant (Industrial Equipment)
04001560	Waste Treatment Reservoir & Dam (1560, 2102)
04001574	Bulk Fuel Farm Substation (1574)
04001575	Bulk Ruel Farm Storage Tanks, Unloading Racks, Distribution Piping and Fire Protection System (1575, 1576, 169)
04001601	Salvage Yard -- Building and Platform (1601, 1605)
04001695	Rocket Igniter Bldg. and checking Station (1690, 1695, 169)
04001697	Decontamination Building (1697)
04002111	Fire Training Area (2111)
04004000	Natural Gas Mains
04000003	Electric Distribution Lines -- Overhead
04010004	Electric Distribution Lines -- Underground
04010006	Street Lights and Cable
04010008	Floodlights
04010009	Security Lights

TABLE 25 Continued

04010011	Traffic Control Lights
04010012	Interior Lighting Systems-All Facilities
04030001	Communication Duct System
04030002	Steam Distribution System
04050000	Potable & Cooling Water Distribution systems -- Main Site
04050001	Catodic Protection
04050002	AEDC Radio Fire Alarm System
04050003	Intrusion Detection System
04050005	Fire & Security Alarm systems (Airport Maint. Bldg.)
04060008	Streets, Roads, Driveways, Storage and Parting Areas, Sidewalks -- Main Site
04060009	Strets, Roads, Driveways, Storage and Parking Areas, Sidewalk -- Outside Perimeter fence
04060010	Painting-Exterior/Interior-All Facilities
04060012	Roofing-All Facilities
04060016	Railraod Trackage and Bridges
04060017	Fencing
04070001	Storm Drainage and Open Drainage Ditches
04070003	Sanitary Sewage Mains
04070005	Telephone Cable System
04070006	Energy Monitoring and Control System
04070007	Information Display System
04070008	Energy Metering System
04152400	Main Substation Cable, Conduit, Manholes, Pull boxes, Grounding, and Miscellaneous
04152401	Main Substation -- Structure
04152402	Main Substation -- Equipment
04152403	Main Substation -- 25,000 KVA Transformer No. 1
04152404	Main Substation -- 35,000 KVA Transformer No. 2
04152405	Load Totalizing equipment (Power Control Building)
04152406	161 KV Carrier Equipment
04152407	D.C. Power Distribution
04152408	Main Substation -- 13.8 KV Switchgear, Indoors
04152409	Main Substation -- 13.8 KV Switchgear, Outdoors
04152410	Main Substation -- 161 KV Control Board
04152411	Main Substation -- Synchronous Condenser
04152412	Main Substation -- Fire Protection System
04152413	Supervisor Annunciator System
04152414	Main Substation -- Fire Protection System
04152415	Pilot Wire Cable System

TABLE 25 Continued

04900008	Rocket Propellant Storage Area and Buildings -- Group IV (2201)
04900010	Utility Buildings at Officers' Open Mess
04900018	Primary Pumping Plant
04900020	Primary Pumping Plant Substation
04900022	Heating Facility Building (Tank Car Storage No. 2, AZ50)
04900023	Main Recreation Area and Bath House
04900026	Farn Building, Well and Pump (3103 and 3105)
04900027	Old Cold Storage Warehouse
04900030	HEF Trailer Pad
04900040	Exotic Fuel Storage Area and Building
04900046	Cemeteries
04900047	Woods Reservoir and Dam
04900049	NCO Club Building, Well and Septic Tank
04900050	AEDC Management Center (2912)
04900055	Waste Fuel Disposal (Old camp Forrest Area)
04900058	Airmen's Recreation Area
04900059	Retention Reservoir and Dam (3101)
04900060	Golf Course and Buildings and Utilities
04900063	N2O2 Unloading Station
04900070	Solid Rocket Fuel Storage Area and Buildings (2204, 2208, 2209, 2210)
04900071	Gage House (Bradley Creek and Elk River
04900072	Softball Field
04900073	Rifle Range
04900074	Radio Beacon Building (at Golf Course)
04900075	AEDC Camp Site
04900077	Pole Unloading Rack and storage (near Gate 7)
04900079	Igniter Storage Building
04900080	Liquid Rocket Fuel Area & Buildings -- Group II (2218, 2219, 2220, 2221, 2222, 2223)
04900081	Officers' Open Mess Picnic Area, Bathhouse, and Tennis Courts
04900082	Officers' Open Mess Building
04900085	X-Ray Building
04900087	Skeet Range and Model Airplane area
04900090	Farm Houses
04900092	Transient Quarters Building
04900400	William Northern Field Items
04901188	Tank Car Storage No. 2 (Building AZ50)
04902224	Hydrogen Transfer Pad (2224)
04902227	N2O4 Transfer Pad (2227)
04902228	Explosive Storage Building (2228)

TABLE 25 Continued

04902302	Airfield -- Runways, Taxiways, Apron and Land (2303)
04902303	Airfield -- Operations Building (2303)
04902305	Airfield -- Ground Control Vault Building (2305)
04902306	Airfield -- Wind Direction Indicators, Beacon and Runway Lighting (2306, 2311, 2312)
04902307	Airfield -- Water Supply Building, Well and Lines (2307, 2313)
04902308	Airfield -- Sewage Plant and Lines (2308)
04902309	Airfield -- Parking Area, Sidewalks, and Storm Drains
04902315	Airfield -- Equipment Storage Shed (2315)
04902320	Airfield -- Lower Power TVOR Building (2320)
04902325	Airfield -- Emergency Power Generator building (2325)
04902327	Fuel Storage Tank (2327)
04902821	Softball Field
04902327	Airfield -- Fuel Storage Tank (2327)
04902821	Airfield -- Softball Field
04903015	Family Housing-Threatre & Hobby Shop (3015)
04903033	Boat Ramp and Facilities -- North of Primary Pumping station (3033)
04903035	Sewage Disposal Containment Building-Family Housing (3035)
04903040	Family Housing (OOM Area)
04903051	Family Housing (#1 Vandenburg Drive)
04903058	Boat Storage Repair Building (3058)
04903060	OOM Storage Building (3060)
04903091	Boat Maintenance Building (3091)
04903092	Boat Storage Building (3092)
04903095	1.5-Mile Running Trail-Arnold Village (3095)
04950000	Potable & Cooling Water Distribution Systems -- Outside Perimeter Fences

21.0 STANDARD SHOP PRACTICES

21.1 PURPOSE

The purpose of this standard is to provide engineers, designers, and drafters with a listing of tolerances that AEDC Shops normally can maintain in machining operations.

21.2 SCOPE

AEDC standard shop practice is to work within the tolerances specified on the drawing, sketch, or NOR. When the term MAXIMUM is specified, it designates the upper limit of a dimension. The lower limit may be considered to be zero unless other elements of the design determine a definite minimum. When the term MINIMUM is specified, it designates the lower limit of a dimension. The upper limit may be considered anything greater than the lower limit unless other elements of the design determine a definite maximum. The use of the terms Max. and Min. for parts which are to be machined following fabrication is desirable and should be used whenever possible to ensure that title block tolerances are not applied to fabricated items.

21.3 AEDC SHOP TOLERANCES

Appendix A lists the machining tolerances normally maintained in AEDC Shops. This listing may be used as a guide to determine the capability of various shop operations. In most cases, closer tolerances can be provided if required for a particular job. However, the originator of such requirements should coordinate with the responsible shop Planner/Scheduler and verify the needed tolerances can be provided. Do not specify closer tolerances than actually needed or tolerances not obtainable in the machine shops.

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APPENDIX A
AEDC SHOP TOLERANCES

21A.1 Diameter Tolerances

Diameter Size (d-In.)	Tolerance (In.)
$1/4 \leq d < 3$	±.010
$3 \leq d < 6$	±.020
$6 \leq d < 72$	±.030
$72 \leq d$	±.060

21A.2 Machined stepped diameters on a common centerline are concentric within .010"

21.A.3 Hole Tolerances

Hole Size (d-In.)	Tolerance (In.)
$0 < d \leq 1/16$	+.004 −.001
$1/16 < d \leq 1/16$	+.005 −.001
$1/8 \leq d < 1/4$	+.008 −.001
$1/4 < d \leq 1/2$	+0.10 −.002
$1/2 < d \leq 3/4$	+.012 −.002
$3/4 < d \leq 1$	+.015 −.002
$1 < d \leq 1\ 1/2$	+.020 −.002
$1\ 1/2 < d \leq 2$	+.030 −.003
$2 < d$	+.060 −.005

21A.4 Tolerances for all sizes of punched holes are

+.002"
− .010"

21A.5 Tolerances for flame-cut holes in mild steel up to 6" diameters and in stainless steel and aluminum up to 2" diameters are ±1/8".

21A.6 Length tolerances for hole locations drilled (non-accumulative) and machined are as follows:

Length (L-In.)	Tolerance (In.)
$1 < L \leq 24$	±1/32
$24 < L$	±1/16

21A.7 Tolerances for the deviation of holes from a stright common centerline are as follows:

Length (L-In.)	Tolerance (In.)
$L < 36$	±.010
$36 \leq L$	±.030

21A.8 Tolerances of hole spacings on bolt circles are one-half the difference between the hole size and bolt size (non-accumulative).

21A.9 The concentricity of multiple bolt circles realtive to a common centerline is within .010 ".

21A.10 The location of longitudinal holes on the axis of a solid bar realtive to the bar O.D. is within .030 ".

21A.11 The ends of any shaft 8" long or longer are center-drilled for machining purposes. Machine centers are not of such depth so as to produce a shoulder and will not be removed unless specified on the drawing/sketch/NOR.

21A.12 Holes and edges are deburred or broken on machine work, and exposed edges deburred on fabrication work.

21A.13 Threaded components are provided as follows:

A. Class 2, unless other specified.
B. Surface finish 125$\sqrt{}$ maximum, unless otherwise specified.
C. Thread relief is at the option of the shop when threading to a shoulder, unless otherwise specified.
D. Male parts thread relief diameter is minimum minor diameter of thread, +.000 and −.005, and the width a minimum of two thread thicknesses with maximum width of four threads.
E. Female parts thread (internal) relief is same as male, except its diameter will be based on the thread major diameter +.005 and −.000.

21A.14 The maximum surface roughuess for various machined surfaces in micro-inches is as follow:

Drilled holes	300√
Reamed holes	l25√
Spot facing	200√
Counter-bored holes	200√
Keyslots and keyways	l60√
Countersunk (flanks) holes	l60√
Threads	125√

21A.15 The maximum surface roughness for the various machine tools in micro-inches is as follows:

EDM	100√
Sander	250√
Mill	125√
Shaper	300√
Lathe	125√
Grinder	637√
Boring mills	l25√

21A.16 The tolerances for fabricated lengths are as follows:

Length (In.)	Tolerance (In.)
1" to 12"	±1/6"
1' to3'	±1/8"
3' to 6'	±3/16'
6' and up	±1/4"

21A.17 Tolerances for sheared lengths are as follows:

Length (L-In.)	Tolerance (In.)
L _ 1/2 thick	±.1/16
L > 1/2 thick	±1/8

21A.18 The tolerances for all thicknesses iof sawed lengths is ±1/16 .

21A.19 Machined inside corner (fillet) radii are .005/.015 R.

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